POWER

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Congress Deliberates

WHAT to do with Muscle Shoals is now commanding the serious attention of Congress. It is a matter of salvaging a vast war expenditure, not merely with the idea of obtaining the greatest monetary return, but also with a view to the benefits to be derived generally from its industrial utilization, at the same time maintaining the state of military preparedness for which the project was initiated.

Mr. Ford's offer has brought the matter to a head. His proposition is the best that has been made thus far, although in the opinion of the Secretary of War and many others its terms should be modified.

Briefly, the arguments in favor of accepting the Ford offer are:

1. Assurance of early local industrial activity on a large scale, which is likely to react to the benefit of the country at large.

2. Prospects of cheaper fertilizer.

3. A guarantee of military preparedness in so far as nitrates are concerned.

4. A fair return on the money necessary to complete the Wilson Dam and construct Dam No. 3, with provision for amortization in one hundred years.

5. Public confidence in Mr. Ford's methods as a manufacturer.

6. He has gone on record with the assurance that all the power available will be used in his own manufacturing enterprises.

Aside from those who oppose the Ford offer through fear of competition, the principal arguments advanced against it are:

1. It would commit the Government to the additional expenditure required to construct Dam No. 3, and Mr. Ford would pay no interest on the cost of securing the necessary flowage rights.

2. Interest payments on the Wilson Dam would begin six years after completion and on Dam No. 3, three years, a nominal rental being paid in the interim. However, the difference between this rental and the interest would amount to six million dollars. This in effect would be equivalent to the Government carrying the "going concern" charges.

3. While there is public confidence in Mr. Ford, there is no assurance that his heirs or interests that may later gain control of his properties will pursue his methods. In view of this there is some hesitancy in committing the Government for so long a term as one hundred years.

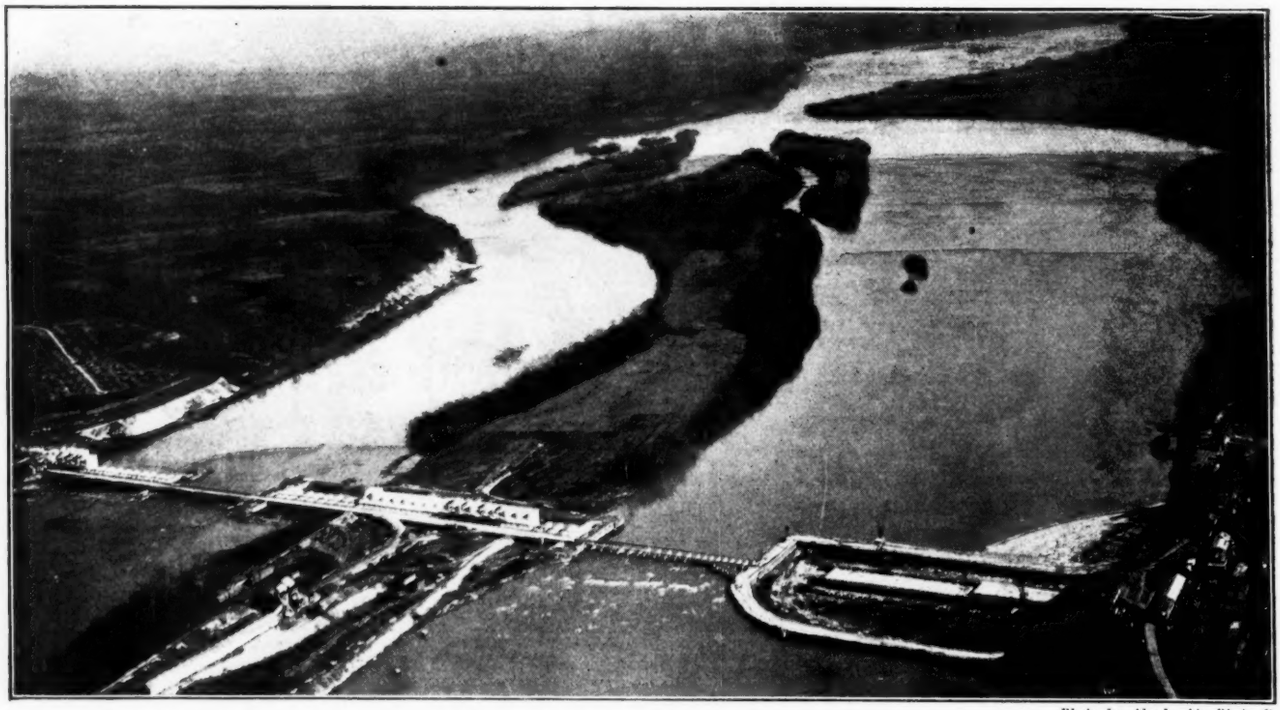
4. Mr. Ford makes no guarantee to manufacture fertilizer throughout the life of the lease.

5. A question whether $5,000,000 is adequate for the nitrate plants and steam power plants.

As concerns the legal aspects of the matter, Mr. Ford has every right to expect clear title to the properties should his proposition be accepted. The fact that officers of the Ordnance Department had a Government power plant and transmission line built on property belonging to a private company when under the war powers it could have exercised the right of purchase, and this without consultation with the Judge Advocate General's office, may be a matter for Congress to inquire into, but it places no obligation upon Mr. Ford or any other bidder. It is a matter for the Government to straighten out first.

Similarly, the Air Nitrates Corporation claims to have an option on the purchase of Nitrate Plant No. 2, based on contracts made by officers of the Ordnance Department, although the Judge Advocate General holds that these options were made without authority. It is significant, however, that the corporation had not seen fit to press its option until the Ford offer was made.

In the event that Congress is unable to secure better terms from Mr. Ford or someone else, it must weigh the advantages against the shortcomings of the offer and decide accordingly.



AIRPLANE VIEW OF WILSON DAM

Photo by Aker's Air Photo Co.

The Disposal of Muscle Shoals

BY R. S. McBRIDE

MUSCLE SHOALS, long a political footfall in our National Legislature, is again before the public because of the several proposals that have been made for its completion as one of the largest power and chemical engineering projects on the American Continent. The project which the Government now has partly developed there originated during the war, when the demand for nitrates with which to make explosives was at its peak. The nitrate from Chile, previously the basis of this industry, was not available in quantities to meet the demand, and it became necessary to take from the air nitrogen which could be "fixed" into useful form. For this purpose two separate nitrate plants were planned and to supply power for these nitrate plants the Wilson dam (also known as Dam No. 2) was started.

EXISTING NITRATE PLANTS

Nitrate Plant No. 1 was projected by the Ordnance Department to fix nitrogen by the modified Haber process of the General Chemical Co. This process takes nitrogen that has been separated from the air and combines it directly with hydrogen that has been separately prepared in pure form. These two gases, which do not combine under ordinary conditions, are made to combine by the assistance of certain "catalysts." The process had been worked in Germany, and experts of the Ordnance Department felt confident that it could be developed along the projected lines within a short time. However, it did not prove successful, and Plant No. 1 never produced useful nitrogen, although it has cost the Government close to $14,000,000.

A large steam-power plant was included as part of Plant No. 1 to supply not only power, but also process steam. This power plant was, in fact, responsible for over a million dollars of the total expenditure. The land on which the plant and the adjoining industrial village were placed and this village together account for over $3,000,000 more of the expenditure; and the roads, sewers, water supply, electric and railway systems cost another million. Thus there is at plant No. 1 useful industrial property representing a large proportion of the total expenditure, and of the $7,000,000 spent on the chemical plant itself, some perhaps can be salvaged for other applications.

Nitrate Plant No. 2 was much larger than No. 1. It was projected at a later date and was to use a process already demonstrated to be a success in the fixing of atmospheric nitrogen on a large scale. It was planned to make calcium carbide, from which calcium cyanamide can be made simply by passing nitrogen over the carbide under appropriate conditions of temperature, pressure, etc. The cyan-

This article has been prepared in order that "Power" readers may have the necessary background to enable them to analyze and judge for themselves the relative merits of Mr. Ford's offer for Muscle Shoals, which is now being considered by committees of both Houses of Congress, also the Alabama Power Co's offer. The author has endeavored to avoid expressing opinions, but has merely suggested the basis for the various arguments pro and con.—Editor.

amide is then treated with steam and ammonia is produced. From the ammonia nitric acid is made, and this nitric acid either serves as the basis of explosives or may be made into ammonium nitrate by combination with more ammonia. This ammonium nitrate was, in fact, one of the most important of the constituents of our high explosives used at the end of the war period. As such it replaced a very large percentage of the TNT which had previously been thought necessary.

Plant No. 2 cost the Government about $71,000,000. Roughly, half of this expenditure went into the chemical plant itself, the balance being distributed in shops; land and village, with its public works, roads, sewers, etc.; a limestone quarry, and a steam-power plant of 80,000 hp.

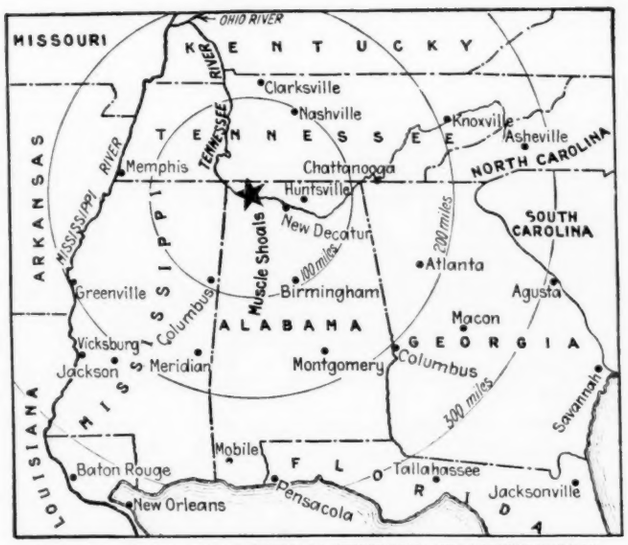


FIG. 1. MAP OF SECTION WITHIN TRANSMISSION DISTANCE OF MUSCLE SHOALS

This plant No. 2 successfully fixed nitrogen for a very short time before the armistice. It could, under present conditions, be continued as a source of ammonia or nitrates. As a matter of fact, it was this plant upon which the War Department two years ago based its proposal that a nitrogen corporation be formed by the Government in order that it might always be adequately prepared with nitrate resources for war explosives and also might meet some of the needs of nitrogen for fertilizers. The Air Nitrates Corporation, under whose patents the plant was constructed, claims an option to purchase it. The Judge Advocate General, however, believes this option to be invalid.

Existing Power Plants

For the operation of Nitrate Plant No. 2, and others which were projected for development if the war had continued with its increasing demands for nitrogen, Dam No. 2 was started. Pending completion of the dam, the nitrate plant was to secure its power from the steam-power plant of 80,000 hp. previously referred to. The dam was projected to supply a total of 500,000 hp., not all of which would have been available continuously since the minimum flow of the river during an average year does not permit in excess of 100,000 hp. continuously throughout the 12 months.

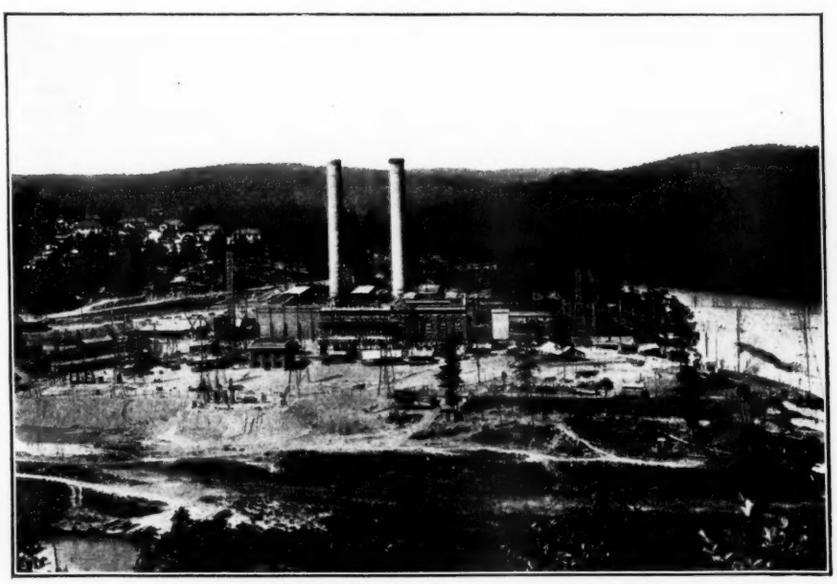


FIG. 2. GENERAL VIEW OF WARRIOR STEAM PLANT

The steam-power installed at the nitrate plant was not adequate for the plant at its maximum capacity, therefore still another power project was undertaken in the form of a steam-power station on the Warrior River, 88 miles distant and close to a coal mine. This plant of about 40,000 hp., with its transmission line to Muscle Shoals, was built on land acquired by the Alabama Power Co. It was constructed for the Government by the Alabama Power Co., on a cost plus basis and cost the Government approximately five million dollars. Thus, there exists a condition where the Government owns the power plant and transmission line and a private company the land on which they stand. Both steam plants and the transmission line are now leased temporarily to the Alabama Power Co. and serve to supply its system during periods of low water, when the utility plants are not able to meet the entire industrial demand. For this purpose part of the steam station at Nitrate Plant No. 2 can be used and the power transmitted from there to the Warrior River Station. The rental amounts to about $200,000 per year, or just about enough to meet the cost to the Government of maintaining the nitrate plant in a standby condition, exclusive of any fixed charges.

By terms of the contract under which the Warrior plant was constructed, the Alabama Power Co. was given certain options on the purchase of the plant and transmission line as an alternative to its removal by the Government. The Alabama Power Co. has notified the Secretary of its intention to invoke this option in the event of Mr. Ford's offer being accepted. The Judge Advocate General, however, has given an opinion that this option would not hold inasmuch as the authority to dispose of Government property is vested solely in Congress. The Wilson Dam was undertaken during the war period under the war authority of the President by funds allotted from the Presidential emer-

gency defense appropriations. It is about 30 per cent completed, and the total of expenditure to date has been $16,250,000. The Secretary of War describes this project in his report to Congress on the offer by Mr. Ford, in the following language:

Dam No. 2, when completed, will have a total length of 4,267 ft., of which 2,890 ft. is a spillway section, 1,221 ft. will be the power-house section, and 156 ft., abutments and approaches. The height of the dam above present low water is 95 ft., including crest gates 18 ft. in height. The total height from the bottom of the excavation for the foundations to the roadway on top of the dam will be 132 ft. There have been no expenditures on Dam No. 3, which is located 14.7 miles upstream from Dam No. 2. Dam No. 2, when constructed, will render 14.7 miles of Muscle Shoals navigable, while Dam No. 3 will overflow the remaining portion of the rapids and will improve conditions of navigation for a distance of 63 additional miles. The present estimates of the Engineer Department for the completion of both Dam No. 2 and Dam No. 3 is $50,000,000. Engineers for Mr. Ford have presented a lower estimate, but Mr. Ford has not seen fit to guarantee the construction for this lower figure.

Dam No. 3, which is also involved in Mr. Ford's offer, has not yet been started; in fact, no detailed plans for its construction have been drawn. Dam No. 1 pertains solely to navigation and has not yet been started. At the close of the war the immediate need for operation of the nitrate plants ceased, and the plants have been idle since November, 1918. However, the Ordnance Department has always felt that some provision should be made to maintain Nitrate Plant No. 2 in good stand-by condition, so that it would be available for the production of ammonia and nitrates if a military emergency should arise. For this reason former Secretary of War Baker and his associates drafted a bill which was presented to Congress in 1920, asking the establishment of a Government corporation which should be known as the Fixed Nitrogen Corporation. However, Congress declined to authorize such an agency, and the new Secretary of War was, therefore, confronted with the problem of maintenance or disposal of the nitrate properties. Furthermore, Congress declined to appropriate additional funds for continuance of the construction work on the Wilson dam. Therefore, about a year ago, when the allotments of war funds were practically exhausted, construction work was terminated, and the property has since simply been maintained in status quo.

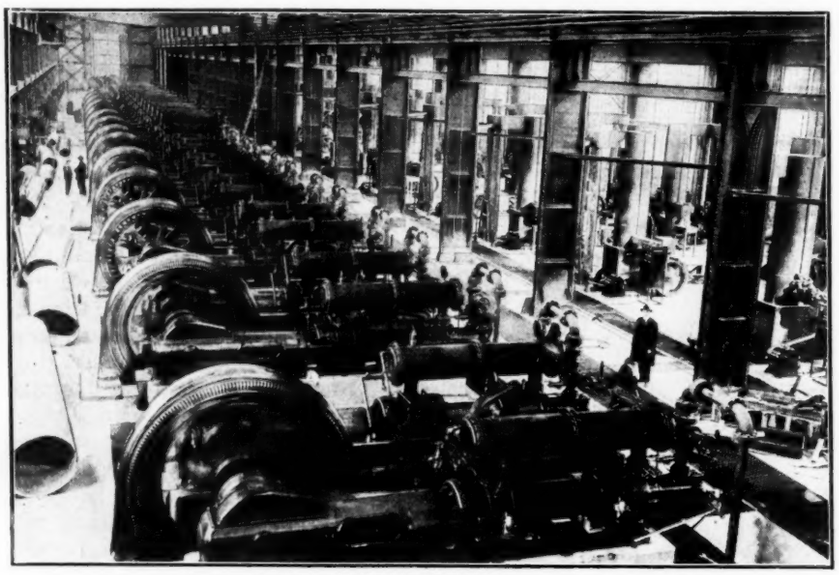


FIG. 3. LIQUID AIR COMPRESSORS, NITRATE PLANT NO. 2

At the beginning of his term Secretary of War Weeks was asked whether he would not recommend again to Congress appropriations to complete the dam. In his recent letter he says on this subject:

In response to such suggestions, I stated that when a proposal was made which would assure the Government a reasonable return on *at least the additional money* required to complete the project, and an effective use of the development for commercial purposes, I would send it to Congress, as the power to dispose of these plants is vested in that branch of the Government.

In July, 1921, Mr. Ford made such a proposal, and during January of this year this was slightly modified; it is this modified proposal which the Secretary has just transmitted to Congress and on which hearings are now being held.

Mr. Ford's Offer

Secretary Weeks describes Mr. Ford's offer briefly in the following language:

In brief, Mr. Ford offers to undertake the completion of Dam No. 2 and the construction of Dam No. 3 according to the Government's plans, for which he shall be reimbursed the actual cost, and to lease the dams and power plants at an annual rental equivalent to 4 per cent of the cost to the Government of completing Dam No. 2 and constructing Dam No. 3 (exclusive of the cost of acquiring lands and flowage rights necessary for Dam No. 3). The rentals of 4 per cent are to commence, respectively, in six years after Dam No. 2 has been completed to the point where equipment for 100,000 hp. is installed and ready for service, and three years after the equipment to develop 80,000 hp. is installed and ready for service at Dam No. 3. In the meantime, during the six-year and three-year periods, respectively, he offers to pay, upon Dam No. 2 an annual rental of $200,000, and on Dam No. 3, $160,000. His offer places upon the United States the responsibility for repair and maintenance of the two dams other than the power houses, which power houses and electrical equipment he agrees to maintain at his own expense in efficient operating condition. As compensation to the United States for the repair and upkeep of Dam No. 2 and locks he offers to pay the sum of $35,000 annually, and of Dam No. 3 and lock the sum of $20,000 annually. He also agrees to furnish electricity for operating the locks at each of these dams without charge to the Government, and in addition he agrees to pay the sum of $23,373 semiannually for the purpose of building up a sinking fund to return to the United States at the end of the lease period, a sum of money which he estimates if invested at 4 per cent will be approximately $49,000,000.

As a condition of this offer he asks that the United States sell to him Nitrate Plants Nos. 1 and 2, the Waco Quarry, and the Gorgas-Warrior Steam Plant, with all appurtenances, for the sum of $5,000,000, payable $1,000,000 down and the balance in annual installments of $1,000,000 each with 5 per cent interest on deferred payments. As a further consideration to the Government he agrees to operate Nitrate Plant No. 2 at the approximate present annual capacity of its machinery and equipment in the production of nitrogen and other fertilizer compounds throughout the lease period, and to maintain it in its present state of readiness, or its equivalent, for immediate operation in the manufacture of materials necessary in time of war for the production of explosives.

He further agrees that the fertilizer produced at Nitrate Plant No. 2 shall not be sold at a profit in excess of 8 per cent of the actual annual cost of production thereof, and to turn over to the United States, Nitrate Plant No. 2 whenever it shall be required for the national defense. He

likewise asks for a preference in opportunity to purchase or lease the property at the end of the lease period and for the right for a period not stated, to be supplied with electric power at reasonable rates in an amount equal to his average consumption during the previous ten years, in case the plant is operated and his company does not purchase or lease it. He also states that his proposal must be accepted as a whole and not in part.

Secretary Weeks' Objections to Ford's Offer

The departure from the present national policy of leasing water-power properties for a period not in excess of fifty years is one objection that has been advanced as a matter of principle. The Secretary points out this objection and asks Congress to determine whether it is of sufficient importance to offset the advantage to the Government in having Nitrate Plant No. 2 maintained in readiness for the manufacture of explosives and in actual production of fertilizer, together with the improvement in navigation which will result from completion of the two dams.

The cash payment of $5,000,000 for outright purchase of the two nitrate plants, the Waco quarry, the Gorgas-Warrior steam plant and transmission lines and the auxiliary equipment, which would pass to the ownership of Mr. Ford's company under the proposal, is also a matter of concern to the Secretary. It is pointed out that these properties cost approximately $85,000,000 and that as scrap they are estimated to be worth $8,800,000.

Any discussion of the cash expected from Mr. Ford for the property which he would buy, must not ignore the fact that most of this is "salvage" property. The loss incurred by its sale is logically chargeable to war's high costs and the general cost of any otherwise useless war material. The sale on the terms offered by Mr. Ford may not be the best if only immediate money return is considered, but other indirect returns will also be had which are no less real because not directly measured in dollars and cents. Furthermore, the percentage of cost to be paid under the offer is comparable with that received by the Government from similar properties at Nitro, Va., and the "Old Hickory" Plant in Tennessee, lying between these two, when so judged on the basis of percentage of salvage value.

If Mr. Ford should complete Dam No. 2 and build No. 3, the installed capacity would be 840,000 hp. However, not quite 140,000 hp. of this would be continuously available for twelve months in a year of ordinary rainfall unless supplemental means were arranged to make more uniform the flow of the Tennessee River.

If Mr. Ford carries out his contract as proposed and operates Nitrate Plant No. 2 "at the approximate present annual capacity of its machinery and equipment in the production of nitrogen and other fertilizer compounds," it is estimated that the equivalent of 110,000 tons of ammonium nitrate per year would be supplied. This represents a considerable supply of usable nitrogen and would undoubtedly affect fertilizer material prices distinctly, and thus also the price of the mixed fertilizers of which nitrogen forms 5 or 6 per cent.

Just what Mr. Ford would do in the way of chemical-engineering development at Muscle Shoals has not been announced. Testifying before the Military Affairs Committee of the House, W. B. Mayo, Mr. Ford's chief engineer, stated that it was Mr. Ford's intention to use all the power for his own manufacturing purposes, part of which would cover the making of automobile parts from the raw materials. He told the committee further that Mr. Ford intended to manufacture fertilizers in finished form and supply the farmer direct, thus preventing the handling by agencies that might fix the price. He would not pledge, however, to manufacture fertilizer during the whole life of the lease.

Arrayed against acceptance of the Ford offer we find certain fertilizer manufacturers, a few electrochemical industries, certain public-utility interests and quite a number of the representatives of "big business," which as a matter of general principle does not care to see any encouragement offered to a financier of large means who, according to their point of view, follows such unorthodox methods as does Mr. Ford. Users of fertilizer are equally strong in favor of acceptance.

Alabama Power Co. Makes Offer

On Feb. 15 Thomas W. Martin, President of the Alabama Power Company, submitted the following offer to the Secretary of War:

1. To take out a license under the Federal Water Power Act under which we will complete the construction of the dam, locks and power house at Muscle Shoals, known as Wilson Dam, or Dam No. 2, at our own expense, with initial installation of approximately 240,000 hp., subsequent installation to be made in accordance with the Federal Water Power Act as may be necessary to meet the market demands.

2. To furnish free to the Government, or anyone it may designate, from the hydro power plant, 100,000 hp. as required for the production of fertilizers and munitions of war and for research in connection therewith; and if, due to changes in the art, this use of such 100,000 hp. is discontinued by the Government, the Alabama Power Co. to purchase and pay for same according to a schedule to be set forth in the license. This power to be the second 100,000 hp. at any time available from the normal flow of the river.

3. To purchase the Government's interest in the Warrior extension of the steam plant of Alabama Power Co., and facilities, the Warrior and Sheffield substations, the transmission line from Warrior to Sheffield, and the steam plant at Nitrate No. 2, together with the necessary rights of way, lands and housing facilities, and to pay therefor in five equal installments the sum of $5,000,000, less an amount to be agreed on to cover the cost of locks and navigation structures at Wilson Dam; the first payment to be made when license is granted, the remaining payments to be made in four equal annual installments with interest at 5 per cent, with the right to anticipate any part or all of same.

4. To operate and maintain the power plant, dam and gates, the Government to operate and maintain the locks for which the Power Company will supply the necessary power without expense to the Government.

5. The Government to transfer to the licensee the Wilson Dam property represented by its investment and commitments to date, free of liabilities and unincumbered, including the construction plant. The locks and navigation structures to be conveyed to the Government in fee on completion of construction.

6. Whenever the safety of the United States demands, the United States shall have the right, as more fully provided in the Federal Water Power Act, to take over and operate the project covered by the license for the purpose of manufacturing nitrates, explosives or munitions of war, or for any other purpose involving the safety of the United States for such length of time as may appear to the President necessary for such purposes.

7. The project covered by the license to be subject to recapture by the Government at the end of fifty years under the terms of the Federal Water Power Act.

8. The licensee will agree to begin the construction promptly upon the enactment of the necessary legislation and granting of license and to complete the same within a reasonable time thereafter.

To facilitate the carrying out of this plan, we may find it necessary to organize a new company for the purpose, in which case, however, the obligations of this offer shall be binding upon this company in all respects.

The Secretary of War has not yet transmitted the Alabama Power Co.'s offer to Congress. He has received two other formal offers, the Engstrum and the Tinker, neither of which contemplate anything like as complete responsibility for development and maintenance as does that of Mr. Ford.

Evaporators—What They Are and How They Operate

This is an elementary article the aim of which is to give the reader a clear idea of the basic principles of evaporators as used in power plants to produce distilled makeup water. No attempt has been made to describe the details of construction and operation. A complete knowledge of the various commercial types of evaporators can be obtained only by extensive study and practical experience. Before attempting a study of this sort, it is best to form a clear mental picture of the apparatus as a whole and the principles of its operation. It is the purpose of this article to give such a picture without burdening the reader with unnecessary technicalities.

IN EVERY steam-power plant, even where the main units are provided with surface condensers, there is a continual loss of water from the system, due to leaks, boiler blowdown and other causes. The loss is rarely less than 5 per cent of the water fed to the boilers and may be much more. This, of course, makes it necessary to supply an equal amount of makeup water. In many places the water supply is unsuited for boiler feed, necessitating some method of purification. This can be done by the process of distillation, carried out in steam-operated "evaporators" especially designed for power-plant use.

Before discussing steam-operated evaporators, let us consider a "still" such as could be used for the production of distilled water on a small scale. Fig. 1 shows a simple form of such a still. Its operation is easily understood. The impure water in *B* is boiled by the flame *A*. The steam produced, practically free from impurities, is carried over into the coiled tube *C* where it is condensed by the cold water in *D*. The distilled water runs into the container *E*.

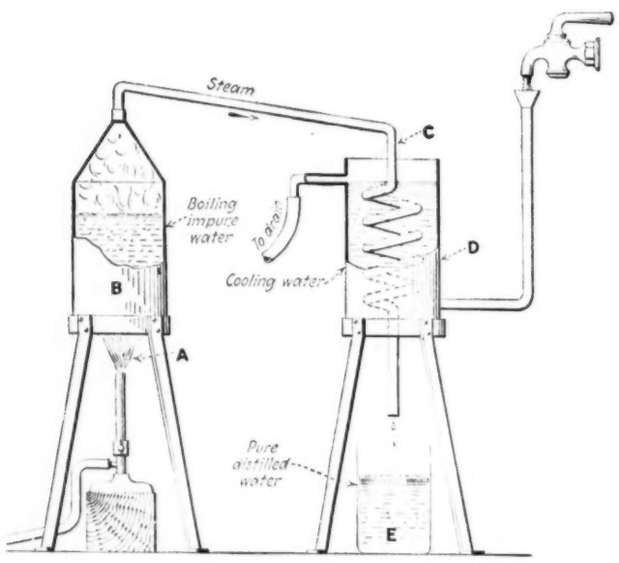


FIG. 1. SIMPLE APPARATUS FOR PRODUCING SMALL AMOUNTS OF DISTILLED WATER

Of course an apparatus of the type shown in Fig. 1 would only be used to produce distilled water on a small scale, but the same idea might be applied in a larger way, using a coal-fired boiler for *A* and *B* and a closed feed-water heater or surface condenser for *C* and *D*. However, power-plant evaporators are almost invariably operated by steam and usually (in stationary plants) by exhaust steam.

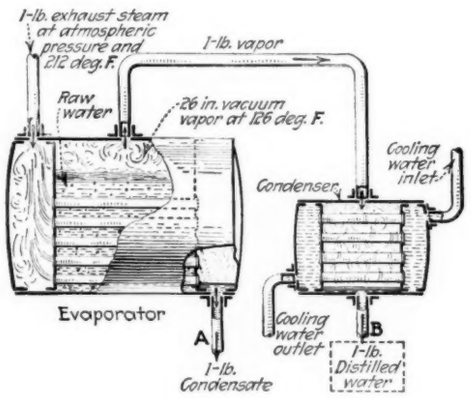


FIG. 2. DIAGRAM OF A SINGLE-EFFECT EVAPORATOR AND CONDENSER

Such an evaporator is shown diagrammatically on the left in Fig. 2. In the simple form shown, it consists of a few tubes connected to the source of steam supply and covered by the water that is to be evaporated.

Temperature Difference is Necessary

A moment's consideration will make it evident that this piece of apparatus will not operate unless the temperature of the steam supplied is somewhat higher than the boiling point of the water. For example, if the steam supplied to operate the evaporator is at atmospheric pressure—that is to say, at 212 deg. F.—it is necessary to maintain a partial vacuum over the water, so that the water will boil at a temperature lower than 212 deg. This can be accomplished by means of an ordinary surface condenser, as indicated on the right in Fig. 2.

In the figure it is assumed that the vacuum maintained is 26 in. At this vacuum both boiling water and the vapor over it have a temperature of 126 deg. It is also assumed that it takes 1,000 heat units to evaporate a pound of water at any pressure and that, similarly, a pound of steam at any pressure gives up 1,000 heat units on condensing. This is only approximately true, but the assumption will simplify the problem and be close enough for this preliminary study. On this basis it is evident that every pound of steam condensing in the evaporator gives up 1,000 heat units, which is just enough to evaporate one pound of water.

Not only is the condenser required in order to maintain a partial vacuum over the water that is being evaporated, but also to condense the vapor into distilled water so that it can be pumped into the system as

makeup water. The water coming from *A* in Fig. 2 is also distilled and should, of course, be turned back into the system. This, however, is not new water and would get back into the boiler in some way (as, for example, through the feed-water heater) even if an evaporator were not used. *So, for each pound of exhaust steam used, we get just one pound of new makeup water.* This is drawn off from the condenser at the point *B* (Fig. 2). The arrangement just described is called a "single-effect" evaporator.

It is also evident that the evaporator itself is a sort of condenser, in that it condenses the steam supplied to it. For this reason it is possible to put two or more evaporators in series with a condenser, as shown in Fig. 3. This arrangement is called a "double-effect" evaporator. Here again the pressure of the heating steam is taken as atmospheric and the vacuum on the second evaporator as 26 in.

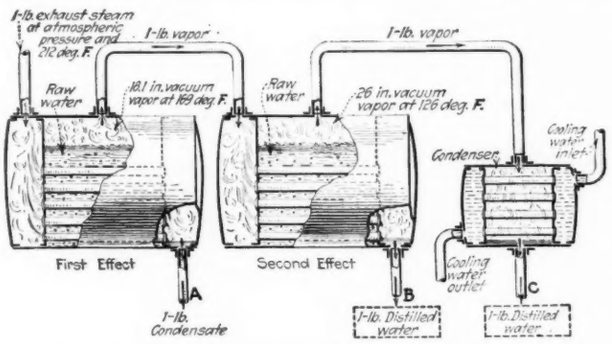


FIG. 3. DIAGRAM OF A DOUBLE-EFFECT EVAPORATOR AND CONDENSER

After the apparatus gets into operation, it works as follows: Steam enters the tubes of the first "effect" and evaporates some of the water in it. The vapor produced passes into the tubes of the second effect and evaporates some more water there. The vapor from the second effect passes into the condenser.

Vapor from First Effect Operates Second

On the assumptions previously stated, it is evident that each pound of steam entering the tubes of the first effect evaporates one pound of water and is itself condensed into one pound of water, passing off at *A*. The pound of vapor enters the tubes of the second effect and is condensed, giving one pound of new distilled makeup water at *B*. At the same time one pound of water in the second effect is evaporated. This condenses in the condenser and appears at *C*, giving a total of two pounds of new distilled makeup water for every pound of steam fed to the double-effect evaporator. The pound of condensate coming from *A* must not be counted as *new* makeup water since it is nothing but the condensation of steam already in the system and is merely *saved*. In operating this double-effect evaporator, the pressure between the first and second stages will automatically come somewhere between atmospheric and 26 in. vacuum.

In a similar way, three or four simple evaporators may be used in series, giving what is called a "triple-effect" or "quadruple-effect" evaporator, respectively. *Using the rough value of 1,000 B.t.u. as the heat exchanged in condensing or evaporating one pound of water, we would find that the following holds true, assuming that no heat is wasted: For every pound of exhaust steam fed, a single-effect evaporator gives one pound of new distilled water; a double-effect evaporator, two pounds; a triple-effect evaporator, three pounds; a quadruple-effect evaporator, four pounds, and so on.*

From this it might appear that the more effects used the better. However, it must be remembered that the rate at which the heat will travel through the tubes depends on the difference in temperature between the two sides. This in turn depends on the pressures, since the temperature of boiling water depends on the pressure. It should also be noted here that the vapor or steam over boiling water is always at practically the same temperature as the water. In a double-effect evaporator the temperature difference between the heating steam and the heated water in a single element is about one-half that in a single-effect evaporator. In a triple-effect evaporator it is about one-third, in a quadruple evaporator about one-fourth and so on. Therefore the more effects that are used, the smaller is the capacity of each effect.

Adding Effects Does Not Increase Capacity

To put it another way, if you had on hand a lot of single-effect evaporators that could easily be connected in series, and if you were using one of them up to capacity, there would be no change in total capacity if two, three, or four of them were placed in series with the same initial pressure and final vacuum; the only result would be to save exhaust steam.

As a definite example of this, let us assume (referring again to Fig. 2) that exhaust steam at atmospheric pressure is fed into a single-effect evaporator and that the vapor produced is carried to a condenser having a 26 in. vacuum. The water around the tubes is then at 126 deg., while the exhaust steam within the tubes has a temperature of 212 deg. The difference of temperature between the two sides of the tubes is 212 — 126 = 86 degrees.

Suppose that under these conditions the evaporator is able to condense 1,000 lb. of exhaust steam per hour and no more. That means that, in the particular evaporator selected, the water around the tubes can condense only 1,000 lb. of steam per hour when the steam supplied is 86 deg. hotter than the water. The 1,000 lb. of exhaust steam condensing per hour evaporates 1,000 lb. of water per hour, and that, therefore, is the amount of makeup water discharged from the condenser.

Changing from Single to Double Effect

Now, if a second evaporator like the first is inserted between the first and the condenser, we have a double-effect evaporator like that shown in Fig. 3. We now get new makeup water from points *B* and *C*, but only 500 lb. per hour from each, so that the total is 1,000 lb. per hour as before.

The reason for this is as follows: The evaporating space of the second effect is at 126 deg. (corresponding to a 26-in. vacuum), but that of the first effect is at 169 deg. (halfway between 212 and 126 deg.). This gives a temperature difference in the first effect of 212 — 169 = 43 deg., and in the second effect of 169 — 126 = 43 deg. The first effect, having a temperature difference only half that for a single-effect evaporator, can condense only one-half as much steam, or 500 lb. per hour. This evaporates 500 lb. of water, which, in turn, is all the second evaporator can condense, since it is exactly like the first effect and operates with the same temperature difference. This in turn evaporates another 500 lb. of water.

So we see that, with the double-effect evaporator, which is obviously almost twice as expensive as a single-effect, it is not possible to produce any more makeup water. The double-effect has one big advantage, it produces 1,000 lb. of makeup water with only 500 lb. of exhaust steam, a ratio of 2 to 1. If a third effect were added, each would produce 333⅓ lb., so that the total water distilled would be 1,000 lb. Only 333⅓ lb. of exhaust steam would be used, a ratio of 3 to 1.

It is now possible to state the general principle (approximate only) that adding more effects of the same size does not change the capacity, but merely makes it possible to produce from one pound of steam as many pounds of distilled water as there are effects.

To make the problem as simple as possible, we have assumed a number of things that are only approximately true. Therefore, the foregoing conclusions are not exact. For instance, the heat required to evaporate one pound of water varies a little according to the pressure, being slightly greater at lower pressures. There are also losses, such as radiation of heat, to contend with. These reduce the amount of water evaporated per pound of exhaust steam. The table gives the theoretical and also the actual figures for average practice.

POUNDS OF MAKEUP WATER PRODUCED PER POUND OF EXHAUST STEAM

Number of Effects	Rough Approximation (Simple Theory)	Average Figures from Actual Practice
1	1	0.9
2	2	1.7
3	3	2.5
4	4	3.2

New Type of Open-Phase and Phase-Reversal Relay

There has recently been developed a new type of open-phase and phase-reversal relay, designed to prevent polyphase motors from running when a phase of the power circuit opens or reverses, with consequent burnouts or damage to the driven machinery. It is used in connection with the control of the motor, both to prevent it from starting when a phase is open or reversed, and to disconnect it from the line if a phase opens while the motor is running.

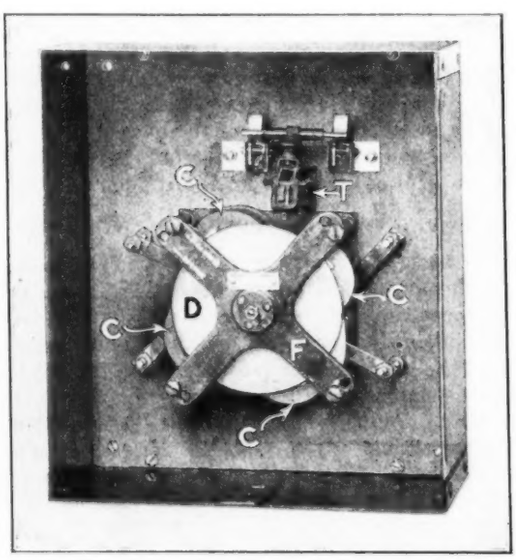


FIG. 1. RELAY WITH COVER REMOVED

In construction the relay, Fig. 1, consists of a frame *F*, two pairs of series coils *C*, and a disc *D* and a toggle mechanism *T*. The frame, which is part of the magnetic circuit, is mounted on the insulating base, and the coils are mounted inside of it. At its center the disc is supported by a pivot which permits it to revolve in a plane parallel to that of the pole faces of the coil magnets.

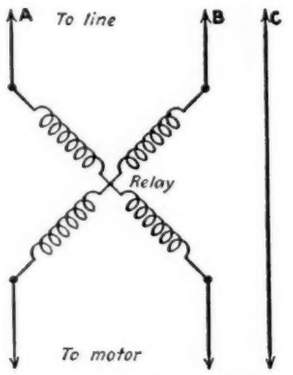


FIG. 2. RELAY CONNECTED IN A THREE-PHASE CIRCUIT

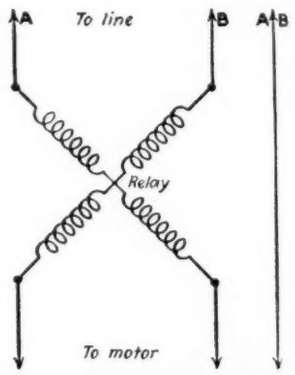


FIG. 3. RELAY CONNECTED IN A TWO-PHASE CIRCUIT

The hand-reset toggle mechanism is tripped by a projection on the disc, as the latter rotates to its extreme limit in a counterclockwise direction.

In operation one pair of coils is connected in series in each of two power lines, as in Figs. 2 and 3, and when the motor starts, current will flow through the coils, producing a magnetic field about the disc, which, when the connections are properly made and the power is normal, tends to turn it in a clockwise direction. The shifting magnetic field produces a torque in the disc that is made up of two components, the normal three-phase one, turning it in a clockwise direction, and a single-phase torque that tends to turn the disc in the opposite direction. When the disc is rotated by the three-phase torque, it is prevented from turning beyond a certain point by a projection on its rim that strikes against a stop on the frame. When a phase of the circuit opens while the motor is running, the three-phase torque is immediately eliminated, and the single-phase torque turns the disc counterclockwise until the projection on it trips the toggle mechanism.

It is the feature of opening the circuit while the motor is running that gives the new relay a desirable protective value. The majority of the other phase-failure relays will prevent the motor's starting in case a phase of the circuit is open, but will not shut it down in case a phase opens while the motor is running. Where shunt coils are used connected directly across the phases, in case a phase opens ahead of the relay, enough voltage may be generated in this dead phase by transformer action in the motor to prevent the relay from opening. With the relay, Fig. 1, however, since the coils are in series with the phases if a phase opens, there is no circuit through the relay coil, and any transformer action in the motor cannot affect the relay's operation.

The relay coils are suitable for connecting directly in the line of any motor whose full-load rating does not exceed 250 amperes at 550 volts. Where either current or voltage exceeds the values mentioned, two current transformers are used. All relays are suitable for use on 25- to 60-cycle circuits, and have been placed on the market by the General Electric Company.

Operation of a Drum-Type, Elevator-Machine Alternating-Current Motor Controller

Functions of the Different Parts and Circuits of a One-Speed Elevator Controller — Tracing Out the Circuits for One Direction of the Machine

By WILLIAM ZEPERNICK

AN ELEVATOR machine operated by a single-speed slip-ring type alternating-current motor, as in Fig. 1, compared favorable in compactness and durability with the single-speed direct-current machine. The control of a single-speed elevator machine operated by a slip-ring type alternating-current motor is simplicity itself; such a controller is shown in Fig. 2. On it *A* is the down-direction and *B* the up-direction switch, which controls the direction of the motor; *P* is the potential switch which opens and closes the main-line circuit and must be closed for either direction of the motor; *O* is the master accelerating switch and *N*, *M* and *L* are the auxiliary accelerating switches, all four of which close and cut out the resistance connected in the rotor circuit. The rotor resistance is made up of cast-iron grids and is shown in the rear view of controller on the right-hand side. This resistance is connected to the slip-rings and is gradually short-circuited out by accelerating switches already referred to in the foregoing.

Some objection might be raised to calling a slip-ring motor a single-speed machine, but for elevator service an alternating-current motor, if not running at high speed (all motor resistance cut out), will give very poor speed regulation; that is, when the car is going up with full load the speed would be slow, while going down the speed would increase to such a point that the speed governor would probably set the safeties. In order to remove the possibility of an operator running the elevator on other than high speed, the car switch for this type of elevator controller is equipped to obtain but one running position for each direction. The circuit for the accelerating magnets is closed by the direction switches, and the time element required to short-circuit all rotor resistance is obtained by means of an air dashpot on the master accelerating magnet.

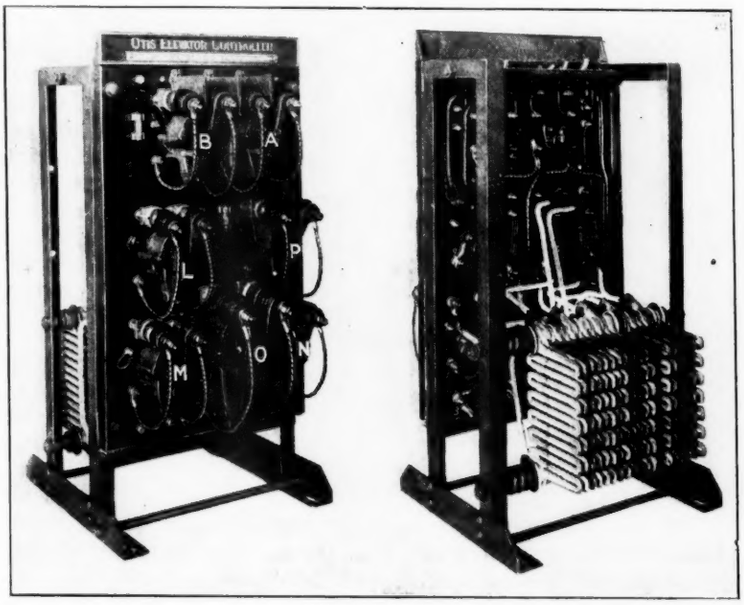


FIG. 2. OTIS ELEVATOR COMPANY'S TYPE NO. 1½ SINGLE-SPEED ALTERNATING-CURRENT ELEVATOR-MOTOR CONTROLLER

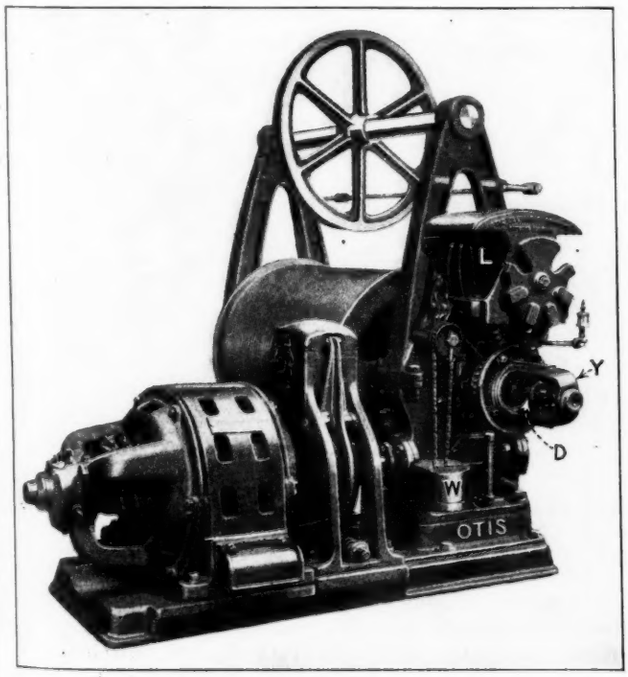


FIG. 1. ALTERNATING-CURRENT DRUM-TYPE MACHINE

Functions of Car-Switch Control

The car-switch control, shown with the cover removed in Fig. 3, is provided with six contact fingers, three for each direction. The two lower contact fingers *L* are connected together and constitute the car-switch feed. Moving the switch handle in either direction permits one of these lower fingers to remain in contact with the contactor *C*, which engages the two fingers provided for each direction. Contact fingers *P* complete the circuit for the potential switch. This circuit is also controlled by protective devices, such as final limits, emergency switch, reverse-phase relay, etc., when provided. The top contact finger *R* provides the circuit to the direction-switch magnet as determined by the position of car-switch control handle. The brake and master accelerating magnets are connected across the motor feeders,

and immediately upon the motor receiving power, the brake releases and the master accelerating switch is energized. Lifting the master accelerating switch, Fig. 4, is controlled by means of an air dashpot, which can be quickened or checked by means of an adjusting screw *S*. As the master accelerating switch pulls in, two small contact fingers, located at *F*, are caused to move over three contact segments, which in turn closes circuits

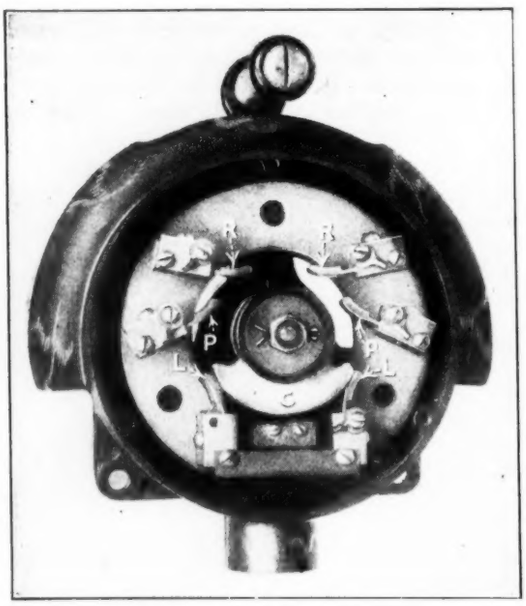


FIG. 3. ELEVATOR CAR SWITCH

for the three auxiliary accelerating switches, one of which is shown in Fig. 5. As these fingers pass beyond the contacts, the auxiliary accelerating switches are released and drop out. When the master accelerating switch has pulled in to the limit of its travel, the main contacts on *O*, Fig. 2, close and short-circuit all the rotor resistance. The small contact fingers at *F* (Fig. 4) have then traveled beyond the contact segments and the three auxiliary accelerating switches are released. These small contacts are arranged so that each successive accelerating switch has pulled in before the preceding switch is released.

A Different Method of Control

An arrangement that eliminates this method of control is the use of auxiliary contacts on each accelerating magnet that closes the circuit for the magnet that follows. The last step of the accelerating magnet closes a contact to become self-holding, and at the same time opens a contact which releases the preceding accelerating switches.

The reversing switches, Fig. 6, are provided with an interlocking bar *C*, which prevents both switches from being either manually or electrically operated at the same time. If these switches should both close at the same time, a destructive short-circuit would result.

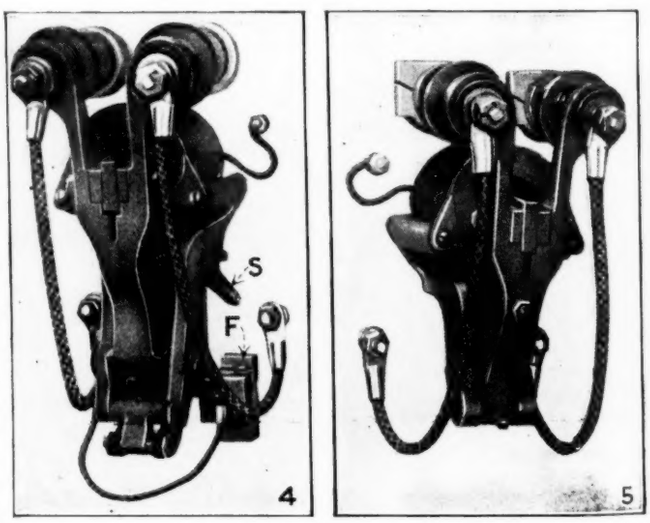
With the drum machine an automatic limit switch, shown at *L*, Fig. 1, is provided, which will stop the machine automatically at the terminal landings, and in addition open the main-line circuit to prevent the machine pulling the car or counterweight into the overhead work. Limit switches are placed in the hatchway, which are opened by a stationary cam attached to the car in case the latter goes a certain distance beyond the top and bottom landings. The opening of the shaft limit switches opens the potential switch on the controller, which interrupts the main power circuit. Shaft-door contacts as well as gate contacts may be used, so that the elevator cannot be started until the doors and gate are closed.

The complete wiring of the controller when used in connection with a drum-type machine is shown in Fig. 7. In order to obtain a clear conception of the circuits, simplified drawings are shown in Figs. 8 and 9. Fig. 8 shows the connections when the elevator is stationary and Fig. 9, when the elevator is ascending.

In Figs. 7 to 9, *A* is the down-direction magnet; D_1 and D_2 contacts closed by *A*; *B*, up-direction magnet; U_1 and U_2, contacts closed by *B*; *P*, potential switch; P_1 and P_2, contacts closed by *P*; *N* is the first auxiliary accelerating magnet; *M*, second auxiliary accelerating magnet; *L*, third auxiliary accelerating magnet; *O*, master accelerating magnet; *F* to F_3, auxiliary fuses; *BL*, bottom-limit switch; *TL*, top-limit switch; *DC*, door contacts; *ES*, emergency switch in car; *SC*, slack-cable switch; O_1, O_2 and O_3, contacts controlled by master accelerating magnet; *GC*, gate contact when used in connection with collapsing gate on car. Nos. 1, 2 and 3 are automatic contacts operated by traveling nut on end of drumshaft at *D*, Fig. 1.

Direction-Control Circuits

As the difference between ascending and descending merely depends upon which direction magnet is energized, the operation of the controller and motor will be considered for the elevator ascending. Door and gate contacts have been indicated, although not always installed. The emergency switch in the car is of the double-pole single-throw type. One side of this switch, together with the gate contact, completes the car-switch



FIGS. 4 AND 5. ACCELERATING CONTACTORS ON CONTROLLER, FIG. 2

Fig. 4—Master accelerating magnet switch. Fig. 5—Auxiliary accelerating magnet switch.

feed line, and both must necessarily be closed to operate the elevator. The door contacts, in series with the final-limit switches, *TL* and *BL*, and one side of emergency switch, complete the circuit from the car switch to the potential switch *P*. These door contacts must be closed in order for the elevator to operate.

When the car-switch control handle is moved in the up position to engage the center contact finger, as in Fig. 9, the circuit is complete from main line 2 through fuse *F*, gate contact *GC*, the lower side of the safety switch *ES* to 29, through the top side of the safety switch *ES*, top hatchway limit *TL*, door contacts *DC*, bottom hatchway limit *BL*, through coil *P* of the potential switch, contact 3′ on automatic No. 3 and back to No. 3 side of the line, as indicated by the arrowheads. Energizing coil *P* of the potential switch causes it to close contacts P_1 and P_2 as shown. There is also a circuit from contact 13 on the car switch to contact 14 through coil *B* on the up-motion contactor, to contact 27 on No. 1 automatic, through the slack cable switch *SC*, fuse F_1, to contact P_1 on the potential switch, and through contacts 9 and 1′ on automatic No. 2 to the No. 1 side of the line. Energizing coil *B* on the up-motion reversing switch causes it to close contacts U_1 and U_2. When contact U_2 is closed, a circuit is made for the brake coil from line 2 to terminal 2*M* on the motor, then around through the brake coil to contact U_2, to P_1 and through automatic No. 2 to No. 1 side of the line. This causes the brake to be lifted, and the motor is ready to start. The motor circuit is from line 2 to 2*M* terminal on the motor, through the motor windings to terminals 1*M* and 3*M*. From terminal 3*M* the circuit is to contact U_1 on the reversing switch, to P_2 on the potential switch, through automatic No. 3 and back to No. 3 side of the line. The other circuit from the motor is from terminal 1*M* to contact U_2 on the reversing switch, through P_1 and automatic No. 2 to line No. 1, as indicated by the arrowheads. Energizing these circuits causes the motor to start with all the resistance in series with the rotor circuit.

The master accelerating magnet *O* is also connected across one phase of the motor, and the circuit for its coil is from 2*M* terminal on the motor through fuse F_2 and coil *O* to contacts U_2 and P_1, automatic No. 2 and to No. 1 side of the line. This energizes coil *O*, and it starts to close the accelerating magnet, but is retarded from doing so by dashpot *S*, Fig. 4. As the switch closes, an auxiliary contact finger *G* is caused to move. When *G* rests on bottom contact O_1 a circuit is completed through coil *N*, which closes contacts *N′* and *N′* and short-circuits out the bottom sections of the rotor resistance and increases the speed of the motor. When *G* moves onto contact O_2, coil *M* is energized and closes contacts *M′* and *M′*, cutting out another section of rotor resistance and further increasing the speed of the motor. Next coil *L* is energized and closes contacts *L′* and *L′*, short-circuiting another section of rotor resistance. Contacts *O′* and *O′* are mounted on the accelerating contactor, and when this contactor has completed its travel contacts *O′* and *O′* are closed by it, thus short-circuiting all the rotor resistance out of circuit and the motor comes up to full speed. In this latter operation contact *G* moves onto *G′*, thus opening the circuit through *L* and causing contactor *L′* to open; contacts *N′* and *M′* having opened previously to this. This permits only the master accelerating magnet to be energized when the motor is under way. The contacts closed by the accelerating magnet short-circuit the rotor resistance in four steps. This resistance, shown in Fig. 2, on the rear of the controller is connected to the rotor winding by means of the brushes and slip rings shown in Fig. 7.

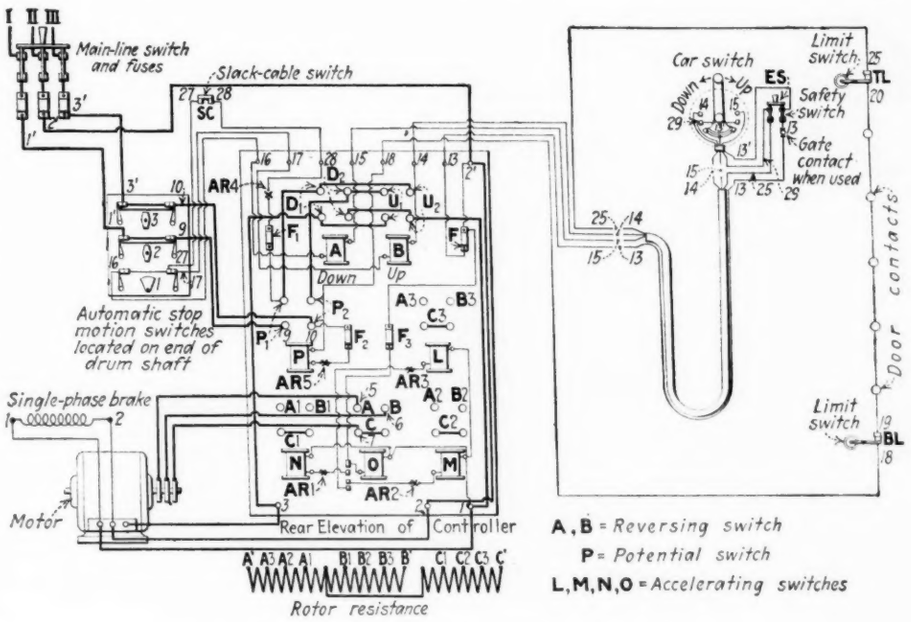


FIG. 7. WIRING DIAGRAM OF THE CONTROLLER, FIG. 2

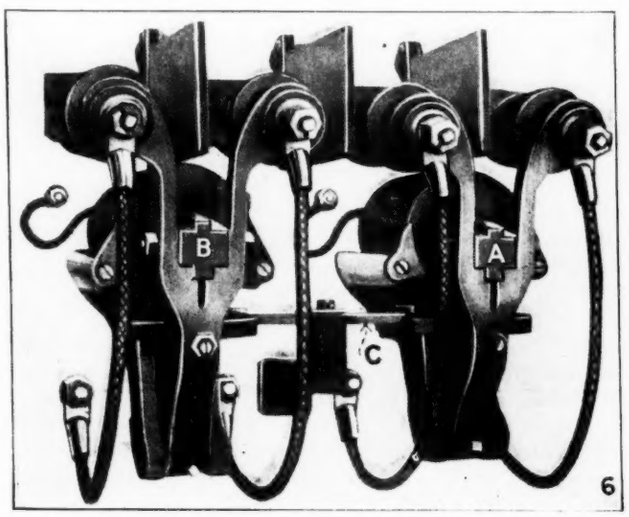


FIG. 6. MOTOR-REVERSING MAGNET SWITCHES

Top-and-Bottom Limit Switches

With the drum type of machine, upon approaching the terminal landings, should the elevator operator neglect to center the car-switch control handle, the automatic will first interrupt the current to up-direction magnet *B*, by opening contact 27 on automatic No. 1 and release

direction magnet *B*. Releasing the direction-magnet circuits will open contacts U_1 and U_2, thus interrupting the current to the motor and bring the machine to rest.

Should the elevator slide an abnormal distance, however, the top limit *TL* will open, preventing the elevator from being operated in either direction, as this will open the circuit to the potential switch *P*. As the limit switches in the hatch are operated by means of cams attached to the elevator car, it is necessary to lower the car by manual operation of the potential switch *P* and the down-motion switch *A* or by means of a crank wrench upon the motor shaft.

Should the elevator travel beyond the final limit switch, automatic contacts Nos. 2 and 3 will be opened, interrupting the line circuit. In this case, to get the elevator into operation, it will be necessary to use a crank wrench or short-circuit the automatic contacts and manually operate the down-direction switch *A* and the potential switch *P*. If the car was in the down motion and run by the bottom landing onto the bottom hatchway limit *BL*, to get the car up it will be necessary to operate by hand the up-motion contactor *B* and the potential contactor *P*, or by using a crank wrench on the motor shaft. Great care should be taken when doing this, for should the wrong direction magnet be closed serious damage may result. When using this method, a person should be stationed to note if the elevator is moved in the proper direction. The elevator should be moved the shortest distance possible until the proper direction is determined.

Diagrams of Controller Connections

For those who wish to do so, the circuits on the simplified diagrams, Figs. 8 and 9, can be easily identified on Fig. 7 and can be traced out in the same way as

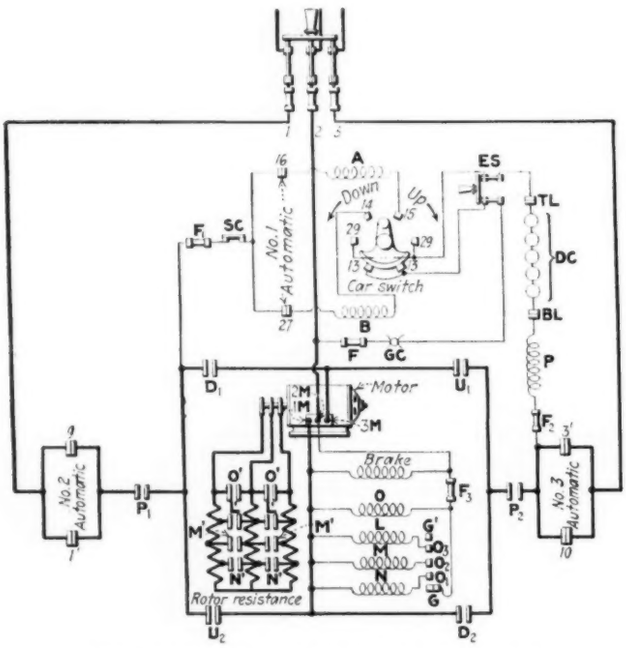


FIG. 8. SIMPLIFIED DIAGRAM OF FIG. 7

explained in Fig. 9. The rotor resistance is not connected in Fig. 7, but its terminals are lettered as are those to which it connects on the accelerating contactors *L*, *M*, *N* and *O*. The various contactors on Fig. 7 are also indicated on Fig. 2. However, it will be noted that they are in reverse order on the diagram to what they are on the photograph; this is due to the Fig. 7 showing a rear view of the controller.

Automatics Nos. 1, 2 and 3 are operated by a traveling nut on a screw attached to the drum shaft, shown at *D*, Fig. 1. The nut is held stationary by means of a bal-

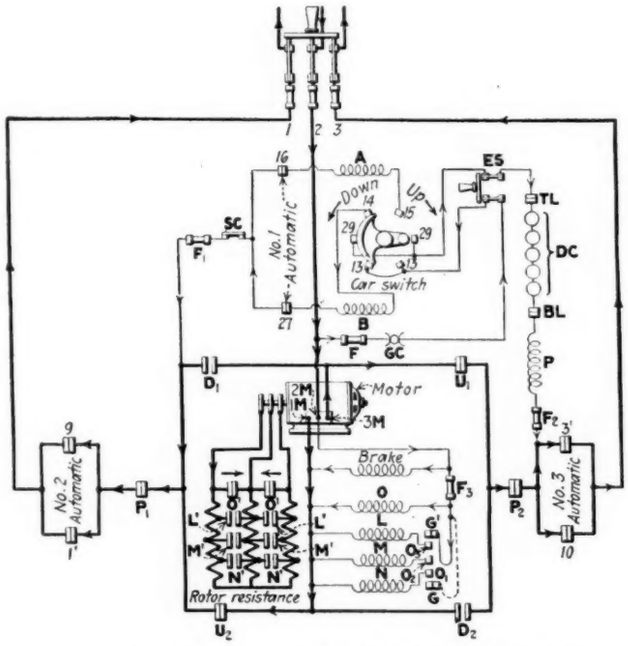


FIG. 9. SAME AS FIG. 8, EXCEPT CONTACTS CLOSED FOR UP-MOTION

ance weight *W*, attached to a chain. The number of revolutions of the screw is determined by the revolution of the drum, which represents the travel of the elevator. At either terminal landing the traveling nut has a definite position on the screw. At these points stationary nuts are clamped to the screw and so constructed as to engage the traveling nut and turn the latter on the former. The traveling nut is equipped with wings which engage the yoke *Y*, causing it to turn at terminal landings. The yoke is geared to the stopping switch *L*, and by means of cams the automatic contacts are opened as described in the foregoing.

When spot-welding high-carbon steels ranging from 0.50 to 0.65 per cent of carbon, certain difficulties are likely to arise that would not occur with low-carbon steel. These are due mainly to the fact that high-carbon steels are hardened by sudden cooling. If the spot welding is performed rapidly and extends over a very small area, the surrounding cold metal produces a rapid chilling of the hot spot, with the result that it is hardened to some extent. The difficulty may be overcome in some cases by heat treating after the weld is made. It is possibly better practice to use a lower welding voltage than would be used with soft steel of the same thickness. By doing this and keeping the heat on longer, a larger area is heated, so that the point where the weld is made is not chilled quickly enough to temper it.

A compulsory boiler inspection bill was introduced recently in the House of Delegates of Maryland, under which inspection would be required of all boilers in the state except small ones as used on farms.

The Steam Line on the Indicator Diagram

Reasons for the Shape of the Line Made by the Indicator Pencil While the Engine is Taking Steam

AT THE beginning of the piston stroke the pipe line and steam chest are filled with steam at practically boiler pressure. Just before the crank passes dead center, the steam valve V being in the position shown in Fig. 2, begins to open, and with boiler pressure existing in the steam chest the pressure within the cylinder immediately rises to the point A on the indicator diagram, Fig. 1. As the piston reverses and starts on its travel to the right, steam from the boiler

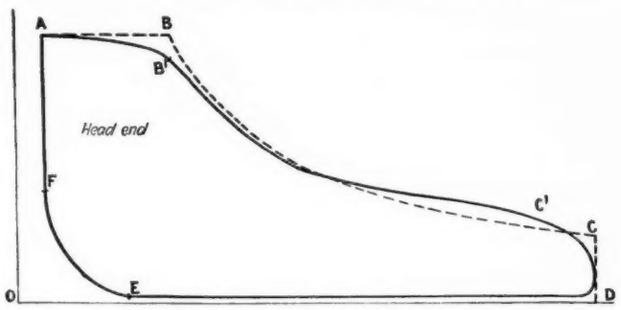


FIG. 1. INDICATOR DIAGRAM

continues to pour into the cylinder; the steam valve V, Fig. 2, meanwhile moves to the left to the wide-open position, reverses its travel and, returning to its original position, covers the steam passage. When the piston is at a point in its stroke as shown in Fig. 3, cutoff takes place and no more steam is admitted into the cylinder. This point is at B on the indicator diagram, Fig. 1. However, in diagrams from the majority of engines the steam line AB is by no means horizontal, but follows more nearly the sloping line AB', the exact shape of the line AB' varying over a wide range.

The only reason steam or any other gaseous substance flows from one place to another is a pressure difference between the two places. To induce steam to flow from the boiler to the engine, the latter must have a lower pressure. In passing along the piping, the steam meets with frictional resistance, the magnitude of which depends on the size of the pipe, its length and the number of elbows and other fittings and the velocity at which the steam must flow to supply the engine. To overcome this resistance and the inertia of the steam may require a considerable difference in pressure between the boiler and engine. The pressure differential is then made up of (a) that required to overcome inertia and (b) that required to overcome fluid friction.

The first may be calculated from the steam velocity

$$h = \frac{V^2}{2g}.$$

Since the head in feet, h, is equal to the pressure in pounds per square foot divided by the density, or $h = \frac{p \times 144}{d}$, we may write

$$\frac{V^2}{2g} = \frac{p \times 144}{d} \text{ or } p = \frac{dV^2}{288g} = \frac{dV^2}{9262.08}$$

in which

V = Steam velocity in feet per second;
g = Acceleration due to gravity = 32.16;
d = Weight of steam per cubic foot;
h = Head in feet;
p = Pounds per square inch pressure drop between boiler and steam chest.

It will be noticed that the pressure drop depends upon the density as well as the steam velocity, or the drop will vary with the boiler pressure carried. Pressure drops for various initial or boiler pressure and various velocities appear in the table.

This pipe-line pressure drop means that the engine steam chest, instead of being at boiler pressure as it would be with no pipe resistance, may be several pounds

PRESSURE DROP DUE TO INERTIA, LBS. PER SQ. INCH

Boiler Pressure Lb. Gage	Velocities in feet per second								
	50	100	125	150	175	200	225	250	275
80	0.058	0.23	0.36	0.52	0.71	0.93	1.17	1.45	1.75
100	0.069	0.28	0.43	0.62	0.85	0.98	1.40	1.72	2.09
110	0.075	0.30	0.47	0.68	0.92	1.20	1.51	1.87	2.27
120	0.081	0.32	0.50	0.73	0.99	1.30	1.64	2.05	2.45
130	0.087	0.35	0.54	0.78	1.07	1.39	1.76	2.17	2.63
140	0.092	0.37	0.57	0.83	1.13	1.47	1.86	2.30	2.78
150	0.098	0.39	0.61	0.88	1.20	1.57	1.98	2.45	2.96
160	0.104	0.41	0.65	0.94	1.27	1.66	2.10	2.60	3.15
170	0.110	0.44	0.68	0.98	1.34	1.76	2.22	2.75	3.33
180	0.115	0.46	0.71	1.04	1.41	1.84	2.33	2.87	3.48
190	0.121	0.48	0.75	1.09	1.48	1.94	2.45	3.02	3.66
200	0.126	0.51	0.78	1.13	1.54	2.02	2.55	3.15	3.81

lower in pressure. Excessive pipe resistance will cause the steam line even at the point of valve opening to be considerably below boiler pressure, as shown in Fig. 4G at A'. If the steam chest is of ample size, the pressure at the beginning of the stroke should approach boiler pressure, since the chest has some opportunity to be filled during the time when no steam is being taken into the cylinder. But with even a generous steam chest the steam-line pressure will show a large decrease after the

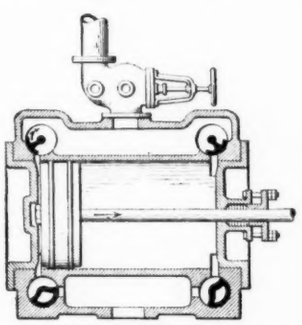


FIG. 2. CORLISS VALVE AT POINT OF ADMISSION

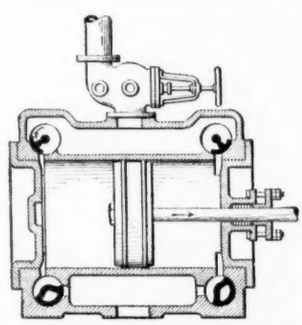


FIG. 3. CORLISS VALVE AT POINT OF CUTOFF

beginning of the stroke to cut-off in the event that the steam-pipe line from the boiler is small. Such a condition is shown in Fig. 4H, where the hump at the beginning of the stroke is due to the large amount of steam in the steam chest. After this initial flow at full pressure the steam line drops off suddenly as a result of the small piping. For these reasons an engine should be provided with a receiver-separator close to the throttle valve, of a volume equal to at least five times that of the cylinder.

An examination of Fig. 1 shows that at the time the valve *V* uncovers the steam port between the cylinder and steam chest, the piston is practically at a standstill. The clearance volume between the piston and cylinder head is small and increases but slowly as the piston starts to move on its stroke. The volume of steam entering this space is small, and its pressure is practically that existing in the steam chest. The continued movement of the piston at an increasing rate requires the rate of steam flow to increase likewise if the steam pressure within the cylinder is not to drop. Insufficient steam flow in the pipe line gives to the steam line most of its departure from the horizontal, this being intensified by the fact that toward the point of cutoff the valve is closing and the port area is decreasing, requiring a still greater steam velocity. In many engines when the average steam flow through the pipe line and valve port is expected to be 6,000 ft. per min., the maximum steam velocity is often over 11,000 ft. per min. Since the travel of the piston before cutoff on the head-end stroke, due to the angularity of the connecting rod, is greater than during the same period on the crank stroke, the head-end diagram usually shows a greater pressure drop on the steam line than does the crank-end diagram.

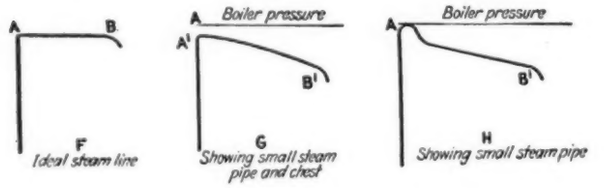


FIG. 4. TYPICAL STEAM LINES

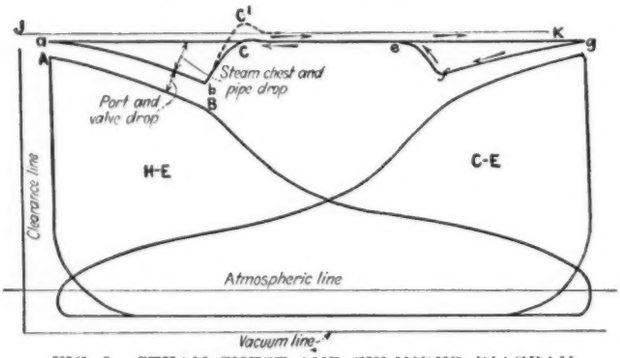


FIG. 5. STEAM CHEST AND CYLINDER DIAGRAM

In order to detect the underlying causes of the "steam line" slope, an indicator should be connected to the steam chart and a diagram taken and superimposed upon the cylinder diagram. Often the same indicator is used for both diagrams. This has the disadvantage of a long pipe connection, producing oscillations of pressure in this pipe that may destroy the worth of the diagram. If at all possible, a separate indicator should be attached directly to the chest. By drawing the atmosphere line on both and having the diagrams of the same length, the superimposing of the steam-chest diagram upon the cylinder diagrams is easily done.

If the steam pipe is too small for the steam demand, the steam-chest diagram will appear like Fig. 5 when *abc* and *efg* are the steam-chest diagrams during the head- and crank-end strokes and *JK* represents the boiler pressure. The depth of these diagrams indicates the steam-pipe and steam-chest pressure drop. If this is considerable in amount, the steam pipe is too small. It is customary to design the pipe for an average steam velocity of 6,000 ft. per min. This may be checked by the engine piston diameter and speed. For example, if the piston speed of the engine is 750 ft. per min. with a steam velocity of 6,000 ft. per min., the pipe cross-section should be $\frac{750}{6,000}$, or one-eighth of the piston cross-section area. In some diagrams the line *bc*, which shows the pressure conditions in the chest after the valve *V* has closed, stopping the cylinder feed, rises above the boiler pressure, as indicated by the dotted line. This is not an error of the indicator as might be assumed, but is a result of the momentum of the steam flowing from the boiler. With a small pipe line the steam velocity is high, and when the passage of steam to the cylinder stops, the momentum of the moving mass of steam causes the steam to "pile up" in the steam chest, increasing the pressure even above that existing in the boiler.

The distance between the steam-chest diagram and the cylinder diagram represents the pressure drop through the valve and port, and as indicated, this increases up to the point of cutoff. In view of the fact that the valve opening decreases before cutoff, causing a very great increase in steam velocity (as high as 11,000 ft. per min. as already pointed out), it is not surprising to find this drop to be quite large in high-speed engines.

Cylinder condensation is one cause of the "steam line" slope, especially in engines using the same port for the exhaust and the live steam. The cylinder is fairly cold when the steam is first admitted, since the walls have been in contact with the exhaust steam during the exhaust stroke. In addition some heat is lost by radiation. Upon the entrance of the steam into the cylinder, its contact with the cold walls causes part to condense. This condensation proceeds during the entire period of steam admission into the cylinder. The condensation collects on the cylinder walls, increasing the conductivity of the cylinder walls and in turn condensing more steam. A greater steam velocity is required to fill the cylinder volume, causing an increased pressure drop.

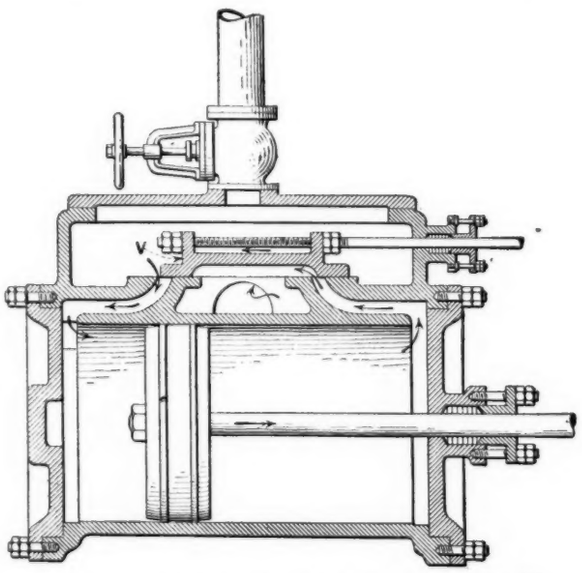


FIG. 6. SINGLE-VALVE ENGINE AT CUTOFF

As a result of the condensation the cylinder volume at the point of cutoff does not represent the volume of the steam actually fed into the cylinder. The volume that would be occupied by the weight of steam fed to the cylinder without condensation may be as much as 50 per cent more than the cylinder volume at cutoff, and is usually from 20 to 35 per cent more.

The shape of the steam line, particularly at the point of cutoff, is also influenced by the design of steam valve.

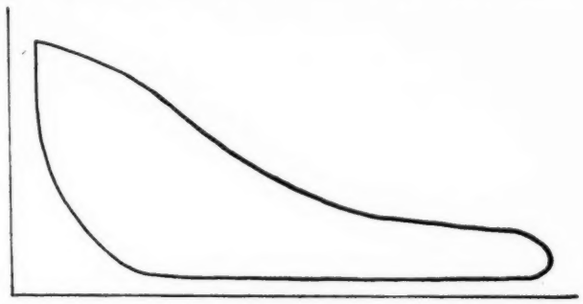


FIG. 7. DIAGRAM FROM SHAFT-GOVERNED SINGLE-VALVE ENGINE

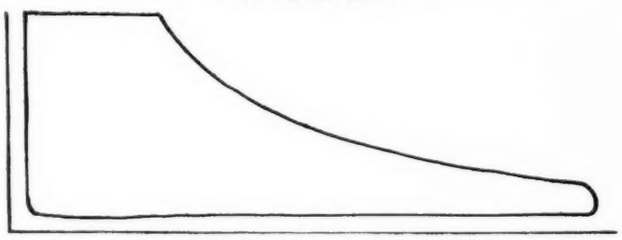


FIG. 8. CORLISS-ENGINE DIAGRAM

With a single slide valve, as in Fig. 6, the travel of the valve is not rapid at the point of cutoff, and wiredrawing of the steam occurs as the valve approaches the edge of the steam port. The steam line shows a marked drop and the exact point of cutoff is indefinite, as shown in Fig. 7, which is from a shaft-governed slide-valve engine. The entire steam line has a slope mainly due to high piston speed combined with a long and tortuous steam passage.

The Corliss engine, since it has ample valve area and a rapid valve opening and closure, maintains a high steam pressure until cutoff takes place. It will be noticed that the Corliss cutoff, Fig. 8, is sharply defined. This is due to the design of valve. When the knockoff cam disengages the valve arm, the dashpot closes the valve. The valve moves very rapidly, and since it sweeps past the port edge at a fairly high velocity, the cutoff is sharp and distinct. From the viewpoint of wiredrawing and heat loss the single-ported Corliss is superior to the double port having an equal valve area. The coefficient of steam flow through the steam port depends on the ratio of port area to port periphery, and obviously the single port of a given area has less edge than has a double port of like area. In addition the heat lost by the steam to the port walls is larger with the double port. To more than offset these advantages, the double port valve requires less movement for a given port area, thereby reducing the work of overcoming the valve friction in opening. The travel is less, consequently the cushioning of the dashpot is more easily secured with the double-ported engine. Since valve speed is limited, owing to mechanical construction, the designer seeks to secure a valve that will give the maximum opening with the minimum travel. This makes the double-ported superior to the single-ported valve, and for this reason it is used on all modern engines.

If the angular advance of the eccentric on a single-eccentric Corliss engine is large, a large area of eccentric travel gives only a small valve travel since the eccentric is well to the end of its throw at the time the steam valve is open. The small valve travel gives a sluggish cutoff. The angular advance also limits the lateness of cutoff.

The non-releasing four-valve engine gives a full-load steam line and cutoff as shown in Fig. 9. The cutoff is by no means as sharp as the Corliss diagram, but the steam-line pressure is fairly uniform. On low loads the four-valve diagram shows considerable wiredrawing before cutoff. This is to be expected, since on low loads the valve travel is short and the speed of valve closing much less than under full-load conditions.

The poppet-valve engine gives a diagram similar to Fig. 10. The point of cutoff is not sharply defined. This is due to wiredrawing through the valve just before closing. The poppet valve is opened by a cam under the control of the governor and is closed by spring pressure. In order to prevent the valve hammering on its seat when closing, the cam contacts with the valve roller before the valve strikes the seat, thereby slowing up the valve, and some wiredrawing occurs. The small width of the valve opening causes wiredrawing during the entire admission at partial loads. With superheated steam the drop in pressure is very small

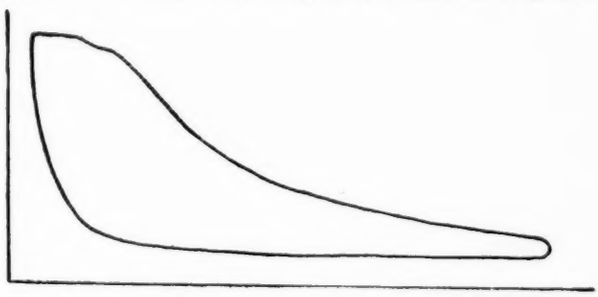


FIG. 9. NON-RELEASING FOUR-VALVE DIAGRAM

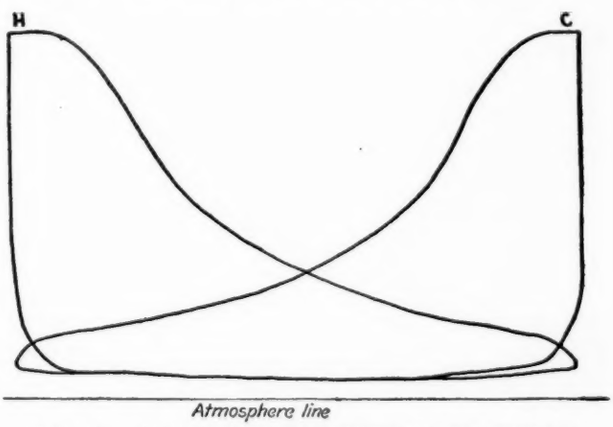


FIG. 10. DIAGRAM FROM POPPET-VALVE ENGINE

until cutoff, showing that cylinder condensation plays an important part in requiring a high steam velocity through the valves. Unaflow engines having poppet valves likewise fail to show a sharp cutoff. The steam line, however, shows but a slight slope since cylinder condensation is reduced to a minimum, and as a result the pressure drop is small.

Cooling Water for Ammonia Condenser

Easy Way to Find the Amount of Water Required

By ALEX. H. LUEDICKE

CONTROL of the flow of condenser cooling water is largely a matter of guess in the average refrigerating plant. If the head pressure gets high, the operator opens the water valve and notes the effect of more condensing water on the pressure. There is, for each condenser, a definite amount of cooling water at any given temperature which must flow over the condenser in order to keep the head pressure down to its proper value.

The chart shown gives the amount of water required per ton of refrigeration for any given condition of evaporating pressure, discharge pressure and range of temperature of the water reaching and leaving the condenser. This is based on the absorption in the evaporating coils of 200 B.t.u. per minute, the amount of heat per minute removed while performing a duty of one ton of refrigeration, plus the heat of compression created while compressing the ammonia vapor in the compressor. In an actual plant the heat in the ammonia going to the condenser may be slightly above the amount calculated, owing to superheat in the suction, but this may be offset by discharge-pipe line radiation, etc.

In constructing this chart the weight of ammonia circulated per minute per ton of refrigeration was ascertained for various conditions of suction pressure by the formula,

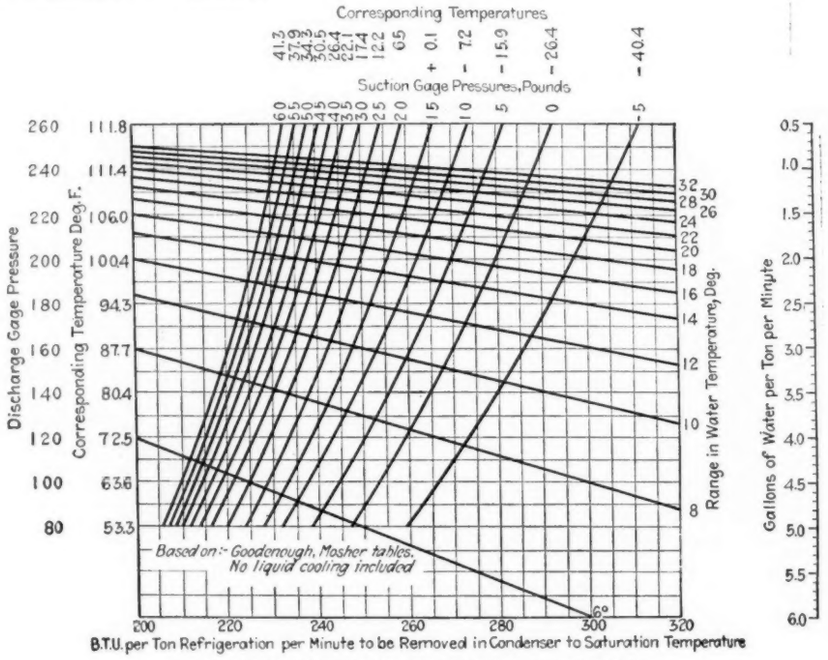
$$W = \frac{200}{H - t_c},$$

where W is the weight of ammonia handled per minute per ton; 200 is the B.t.u. equivalent of one ton of refrigeration duty per minute; H is the total heat in one pound of ammonia vapor at the suction temperature; and t_c is the temperature of ammonia in the liquid receiver.

This formula gives the weight of ammonia per ton. The heat in each pound after compression was secured from a Mollier heat chart, based on Goodenough's tables (see *Power*, Nov. 29, 1921).

The values of B.t.u. per ton per minute to be removed in a condenser are plotted as ordinates on the chart, the discharge gage pressures are shown as abscissas and the suction gage pressures are plotted over these two. To find the B.t.u. to be removed, trace the given compressor-discharge gage pressure horizontally to the right until it intersects the given suction pressure, trace downward vertically and read the result on the lower horizontal line. For example, at 200 lb. gage discharge and 20 lb. gage suction pressure, 249.6 B.t.u. would have to be removed per ton per minute.

An additional scale is provided at the right of the chart, giving the gallons of water per minute per ton. The range in water temperature or difference in temperature between entering and leaving water is plotted in the form of diagonal lines, and these are used in conjunction with the curves previously mentioned and the vertical water scale. For instance, we require the number of gallons of water per minute per ton at 200 lb. discharge and 20 lb. suction pressure with a 20-deg. cooling-water temperature range. Trace the 200-lb. line horizontally to the right, intersecting the 20-lb. suction curve and trace vertically upward from this point until the 20-deg. range line is intersected, then trace horizontally to the right and read 1.5 gal. per ton per minute.


Corresponding Temperatures
41.3 37.9 34.5 30.5 26.4 22.1 17.4 12.2 6.5 + 0.1 - 7.2 - 15.9 - 26.4 - 40.4
Suction Gage Pressures, Pounds
60 55 50 45 40 35 30 25 20 15 10 5 0 -5
Discharge Gage Pressure
Corresponding Temperature Deg. F.
260 240 220 200 180 160 140 120 100 80
111.8 111.4 106.0 100.4 94.3 87.7 80.4 72.5 63.6 53.3
Range in Water Temperature, Deg.
32 30 28 26 24 22 20 18 16 14 12 10 8
Gallons of Water per Ton per Minute
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0
Based on Goodenough, Mosher tables. No liquid cooling included
6°
200 220 240 260 280 300 320
B.T.U. per Ton Refrigeration per Minute to be Removed in Condenser to Saturation Temperature

CONDENSER COOLING-WATER DIAGRAM

The method of arriving at the range in water temperature rests with the user and depends on the type of condenser used. For instance, with a double-pipe condenser and 70-deg. water, allowing 18 deg. range, the outlet temperature of water would be 88 deg., and allowing 5 deg. difference between condenser temperature and outlet-water temperature due to transmission through iron pipe, the condenser temperature would be 93 deg. F., which corresponds to a pressure of approximately 176.2 lb. gage. Under the given conditions and with 20 lb. suction gage pressure, 1.64 gal. would be required per minute per ton. If this should be more water than is available, a greater range will have to be chosen, and this would result in higher discharge pressure and consequently more power to drive the compressor. For instance, the foregoing conditions would require 1.25 indicated compressor horsepower per ton of refrigeration, and if a 20-deg. range should be used, the condenser temperature would be 70 + 20 + 5 = 95 deg., corresponding to a discharge pressure of 182.6 gage and would require only 1.48 gal. per min. of cooling water, but would necessitate the expenditure of 1.28 indicated compressor horsepower per ton of refrigeration.

Locating Faults in Direct-Current Armatures—Short-Circuits in Parallel Windings*

Methods of Locating Defects in Windings, with a Low-Reading Voltmeter, Before the Machine Is Put into Service Are Explained and Test Made for Short-Circuits in a Parallel Winding

By B. A. BRIGGS

WHEN a motor or generator is put into operation, any short-circuited coils or short-circuits in the commutator will manifest themselves by heating. However, these defects should be located and repaired before the machine is put into service. This may be done by passing a current through the armature and then measuring the volts drop between the commutator bars with a low-reading voltmeter. The instrument should preferably be of the permanent-magnet movable-coil type, as this type is more sensitive than others and will read with the current flowing in one direction only; otherwise the needle will be deflected back off the scale. This feature is also desirable in the location of cross-connected coils as will be explained in another article.

For convenience the armature should be supported upon some such a device as shown in Fig. 1. In some cases the pedestals are mounted on a low truck so that the whole equipment can be conveniently moved from one place to another. To make connection with the commutator so that the current can be passed through the coils, the line leads may be tied in place by binding them under two or three turns of stout cord around the commutator, or a special set of brushes mounted on a strap may be used so that the brushes may be adjusted to meet the requirements of different-sized commutators. The resistance of the armature in all cases will be low, therefore an external resistance will have to be connected in series with it to adjust the current to a suitable value should other than a low voltage be available.

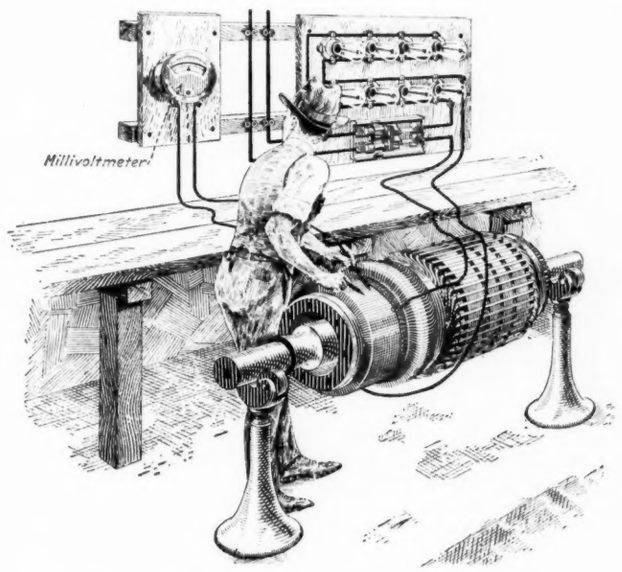


FIG. 1. ARRANGEMENT OF EQUIPMENT FOR TESTING ARMATURES

For a small-sized armature a suitable resistance can be made by connecting a number of lamps in parallel, as shown in Fig. 1. Where there are a considerable number of armatures to test, such as will be found in repair shops, it is good practice to provide a low-voltage generator driven by a motor, to supply the test current. the voltage of the generator being adjusted by a field rheostat to give the desired value of current. However, the arrangement shown in Fig. 1, will serve the purpose nicely in a large percentage of cases. Where a large armature is being tested, sufficient current cannot be obtained through an ordinary bank of lamps, to give a suitable deflection on the instrument. In such cases a water rheostat can be substituted for the lamp bank or connected in parallel with it.

For making the test, a millivoltmeter or direct-current ammeter without a shunt serves the purpose best. The location of the current leads on the commutator will depend on the type of armature. If the armature is parallel wound, the contact on the commutator can be located on opposite ends of the diameter, as in Fig. 2. In this case the winding is for a four-pole machine, but the leads connect to the commutator as if the winding were for a two-pole machine. In tracing out the circuit through the winding, it will be seen that all coils are in circuit. The current flows from the + terminal through the lamps to segment 7, then divides, part of it flowing through coils 7, 8, etc., to segment 19 and to the — terminal. The other half of the current flows through coils 6, 5, 4, etc., around through the other half of the winding to segment 19 and to the negative terminal. In both cases there are 12 coils in series, therefore if all coils are in good condition the current through each path will be equal. Before making the test, the current is adjusted to a value by turning on the lamps that will cause a suitable deflection on the instrument, which should be about halfway across the scale. After that has been done, the meter leads are touched to two adjacent segments and the deflection noted. If this is too low, more lamps may be turned on, and if too high some of the lamps may be turned off until the proper adjustment is obtained.

If the meter is connected to two segments—for example, 8 and 9, Fig. 3—current will not only flow from segment 8 through coil 8 to segment 9, but also from segment 8 through the meter to segment 9, which will cause a deflection of the needle. It is well to take a reading at two or three points on the commutator so as to obtain a good average deflection. Then, beginning at, say, segments 8 and 9, take a reading, then from 9 and 10, 10 and 11, etc., around the commutator. With the leads on segments 8 and 9 the flow of the

*All rights reserved.

current through the meter is into lead *A* out on lead *B* to segment 9. Now, after we have worked around the commutator and passed the brush on segment 19, the millivoltmeter leads will connect to segments 20 and 21, deflection—but all that is necessary is to reverse the instrument leads to obtain a normal reading.

Now, when everything is ready to make the test, start at, say, segment 8 and touch the meter leads to

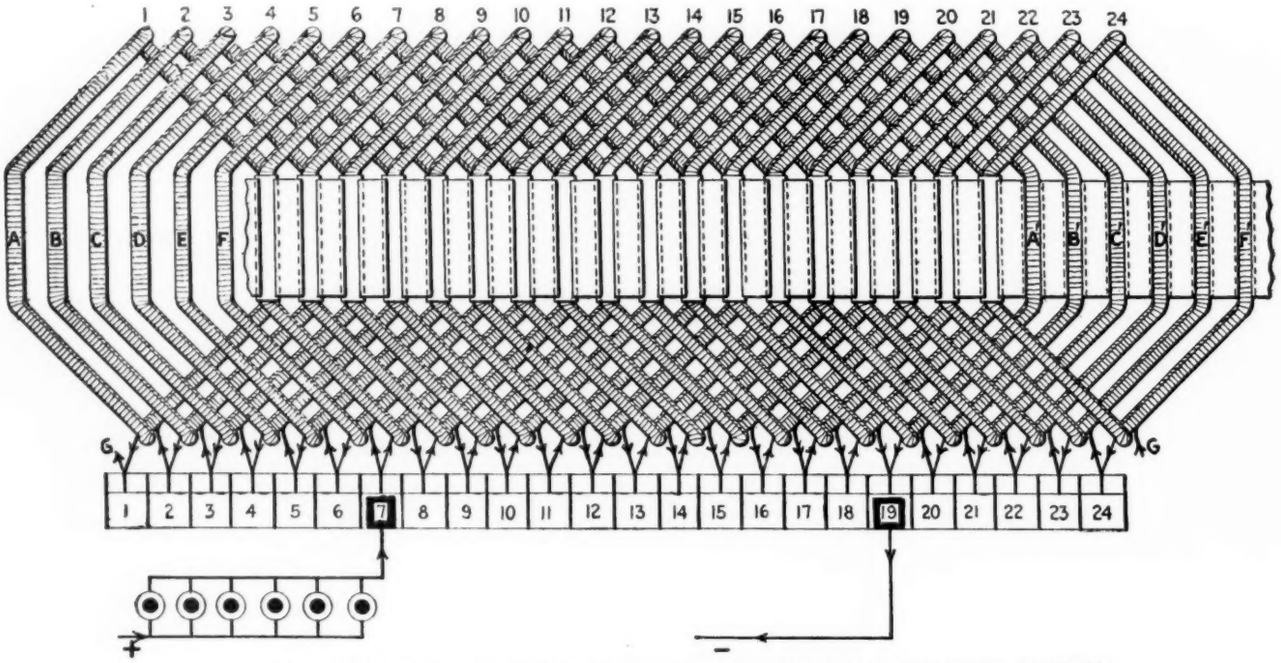


FIG. 2. CONNECTIONS FOR SENDING TEST CURRENT THROUGH ARMATURE WINDING

as indicated in dotted lines. It will be observed that in this case the current flow is from segment 21 into lead *B'* and out on *A'*, which is the reverse of what it was when the instrument was connected to segments segments 8 and 9. Coil 8 connects to these two segments, and if it is in good condition a normal throw should be obtained on the meter, for example, halfway across the scale. Then, take a reading from segments

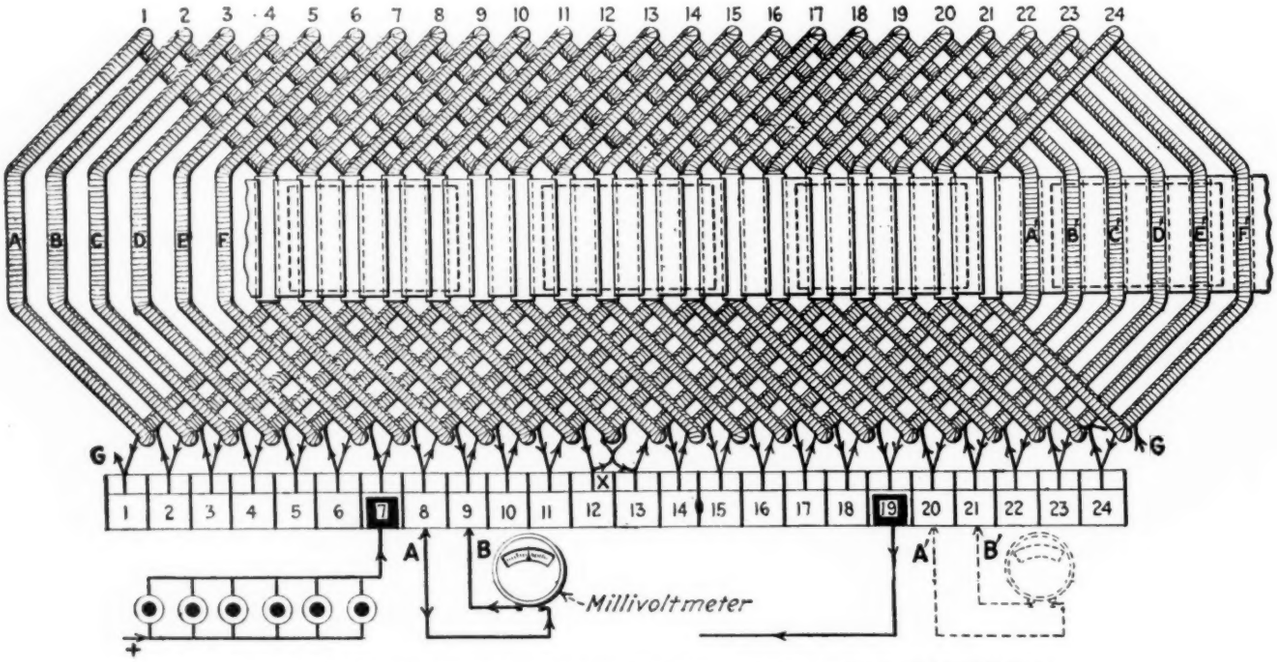


FIG. 3. SHOWS HOW TESTS ARE MADE FOR SHORT-CIRCUITS IN WINDINGS

8 and 9, 9 and 10, etc. This reversal of current through the meter will cause a reverse deflection of the needle. This will be found to hold true in all cases when the test is shifted from one side of current leads on the commutator to the other—the meter will give a reverse 9 and 10, and if coil 9, which connects to these two segments, is in good condition a throw of half scale should be obtained on the instrument, as for coil 8. Suppose that the insulation between two of the turns in coil 9 has become injured and allowed them to come

together, then part of this coil would be cut out of circuit. Therefore, it will require less voltage to cause the current to flow through coil 9 than when all the turns are in circuit; consequently, when the meter is connected to segments 9 and 10, the needle will not be deflected so far as when connected to good coils. A lower reading, therefore, indicates a short-circuit in a coil. Assume a case where the leads of coil 12 come into metal-to-metal contact, such as indicated at *X*, then this coil would be cut out of circuit. The only

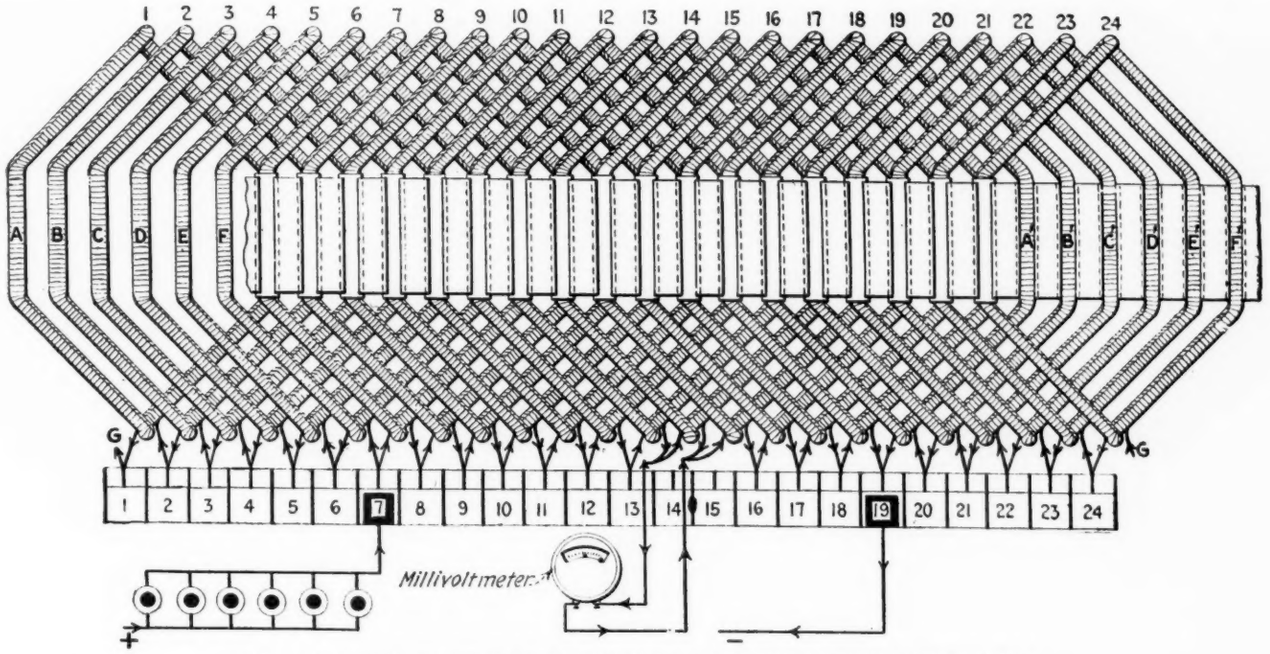


FIG. 4. TESTING TO FIND IF FAULT IS IN A COIL OR IN THE COMMUTATOR

voltage necessary to cause current to flow from segment 12 to 13 is that required to overcome the resistance of the leads. This resistance is very small, consequently when the instrument is connected to segments 12 and 13 the reading will be low or zero, which would show that there was a dead short-circuit of the coil, or between segments 12 and 13.

If there were a short-circuit between segments 14 and 15, then current could flow directly from one segment to the other without going through coil 14, which connects to these two segments. This would require a much lower voltage than to cause the current to flow through the coil, therefore the meter will read low when connected to these segments. The deflection on the meter in this case will depend on the resistance of the defect. If the defect consists of a little carbonized mica, then its resistance will be comparatively high and the deflection on the meter may amount to one-half or three-quarters of normal. On the other hand, if the defect is metal-to-metal copper, the reading may be zero. After these defects have been located, it is necessary to ascertain if they are in the coils or the commutator. This can be done by disconnecting both leads from the two segments, as at segments 14 and 15, Fig. 4.

If the two leads from each segment are soldered together as shown, the circuit through the winding will be complete and a test of the coil can be made with the meter as indicated. If the instrument reading is normal, then it is known that the defect must be in the commutator. The defect between the segments can be tested with a lamp and circuit. If the fault is carbonized mica only, the lamp current will probably heat it to the glowing point or cause smoking. On the other hand, if the defect is of low resistance, then the lamp will light to full brilliancy. When the defect has been located, the method of removing it will depend upon conditions and was discussed in the article "Repairing Short Circuits," page 94, Jan. 17 issue. The defects could also be located with a telephone receiver. Coils that are defective will give a lower click in the receiver when its leads are touched to the commutator segments than will the coils that are in good condition.

[*The next article will discuss the location of short-circuits in a series winding.*]

Concentrated sulphuric acid is characterized by freedom from odor, has an oily appearance and is heavy in weight. Pure acid is colorless, but in commercial acid there is usually a gray color, due to the presence of organic matter. It is exceedingly hydroscopic; that is, it attracts the moisture from the air and, when exposed, rapidly increases in bulk owing to the absorption of atmospheric moisture. For storage-battery electrolyte, distilled water is used to dilute the acid in order that it may be pure. The greatest care is necessary to maintain all materials used in the manufacture and installation of batteries absolutely pure. Impurities disintegrate the active materials or set up local electrical actions which waste energy and reduce the efficiency of the battery.

It is recommended by the Hydraulic Society that the following piston travel be considered as maximum for boiler feed service per side per minute:

3-inch stroke	18 ft.	6-in. stroke	26 ft.
4-in. stroke	22 ft.	8-in. stroke	30 ft.
5-in. stroke	24 ft.	10-in. stroke	33 ft.
		12-in. stroke	39 ft.

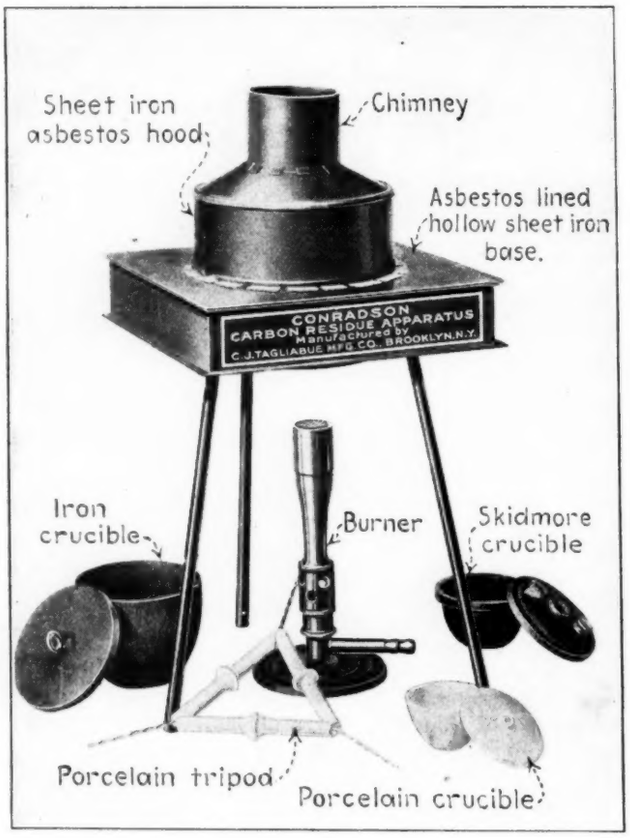
For general service these speeds can be increased approximately 50 per cent.

Lubrication—Carbon Residue

By W. F. OSBORNE*

EVERY oil contains the element known as carbon. Petroleum oils contain carbon combined chemically with hydrogen in varying amounts, the average percentage of carbon for lubricating oils being about 85 per cent. Animal and vegetable oils also contain carbon in combination with hydrogen, oxygen and other elements.

So long as we use oils for lubrication, we will always have carbon. It is not the amount of carbon in the oil that causes carbon deposits, but its tendency to separate from the other elements. The way in which the carbon atom is combined with hydrogen and other carbon atoms regulates its tendency to separate under operating conditions. Graphite is practically 100 per cent carbon and is considered by some people to be a desirable lubricant. Trouble from carbon deposits comes when the carbon partly or completely separates from the other elements and collects in more or less solid masses in cylinders, on valves and other points where it may interfere with the operation of the machine. If the separated carbon were dry, it would be carried away, but since it is usually partly combined with oil, it sticks and forms a gummy mass.



CONRAD CARBON RESIDUE APPARATUS

Carbon deposits may be considered as the result of a partial decomposition of the oil, which may be due to the oil having been improperly refined, or may be due entirely to natural causes inherent in the operation of the machine on which the oil is used. Compounds that might cause trouble later on are to a very large extent removed in the refining process, the degree of this treatment determining many of the grades of oils on the market. Certain oils that are very satisfactory for the lubrication of a ring-oiled bearing might cause trouble through carbonization if used for the lubrication of an air compressor or Diesel-engine cylinder. The importance of a thorough knowledge of this tendency of oils to decompose when subjected to heat and pressures of service conditions, has resulted in the development of a test to show the action of an oil under such conditions.

This test, known as the "Carbon Residue Test," has been standardized by the American Society for Testing Materials and consists of heating a definite quantity of oil in a vessel free from sufficient air to cause the oil to burn, until all the oil has been evaporated, leaving in the vessel nothing but a residue of carbon which is due to the partial decomposition of the oil under the conditions of test. The percentage of this carbon, as compared with the weight of the original oil, is called the carbon residue. It varies with different oils, according to the method of refining and the crude from which the oil is made. The Conrad carbon residue apparatus is shown in the illustration. As a rule oils made from paraffin crudes will show a higher carbon residue than oils of similar grades made from the naphthene crudes, if oils of the same viscosity and refinement are compared. Furthermore, the residue from the naphthene oil is usually soft and flaky, whereas that from the paraffin oil is hard and crystalline in appearance.

When testing oils made from the same crude, it will be found that the lower viscosities form the smaller amounts of carbon residue, which increases quite rapidly as the viscosity rises. For example, a naphthene-base oil of 200 seconds viscosity may have a carbon residue of 0.005 per cent, while a 750-seconds viscosity oil might show 0.15 per cent.

As a rule a straight-run oil will evaporate more cleanly and with the formation of less carbon deposits than a blended oil. This is due to the fact that the straight-run oil is composed of compounds having boiling points fairly close together. When the temperature becomes high enough to evaporate any part of the oil, practically all of the oil goes off together. A blended oil, on the other hand, being composed of compounds having both low and high boiling points, loses that part which evaporates at low temperature, the other portion remaining unevaporated until it decomposes with the formation of carbon.

The carbon residue of oils sold for internal-combustion engines and air-compressor cylinders varies from 0.001 per cent up to as high as 2.5 per cent for some undesirable grades of heavy blended oils. The carbon residue allowed by government specifications for air compressors and internal combustion cylinder oils is as follows: Extra light oil, 0.10 per cent; light oil, 0.20 per cent; medium oil, 0.30 per cent; heavy oil, 0.40 per cent; extra-heavy oil, 0.60 per cent.

*Supervisor Manufacturers' Service, Texas Company.

Turbo-Blowers for Mechanical-Draft Applications

Four Blowers Are Worked in Parallel and Directly Connected to a Turbine Operating at 5,000 R.p.m.—These Machines Are Applied to Both Forced- and Induced-Draft Purposes

ALTHOUGH the use of turbo-blowers is not new in their application to mechanical-draft purposes, the unit shown in Figs. 1 and 2 possesses some interesting features. Instead of a single blower wheel, as is frequently used, four impellers are arranged to operate in parallel. The air impellers, two of which are shown in the right-hand foreground, Fig. 2, are of the helicoidal type, and two are mounted on a common shaft to form a blower, one of these being connected to each end of a steam-turbine shaft. The machines, one of which, for forced-draft service, is shown in Fig. 2, were built by the Rateau Battu-Smoot Co. to supply forced draft to a water-tube boiler having 6,000 sq.ft. of heating surface. The boilers are equipped with separate economizers and fired with chain-grate stokers, and the blowers are capable of operating them up to 250 per cent of rating. The air is taken in at the ends of the blowers and discharged through the square opening in the center into the air chamber under the stokers. Induced-draft units have also been constructed to operate with these boilers. These units are similar to the forced-draft blowers except that the casing incloses the entire blower and is bolted to the uptake so as to form part of the breeching from the boiler to the stack.

These machines have a normal capacity of 30,000 cu.ft. of free air per minute at pressures up to 7 in. and operate at 5,000 r.p.m. As the impellers are 18 in. in diameter, a tip speed of 23,500 ft. per min. is obtained. The high speed results in a compact construction giving dimensions for the entire unit of 9 ft. 2 in. long, 3 ft. 1 in. wide and 3 ft. 5 in. high, or a floor area of about 28 square feet.

A section is shown through one blower and turbine in Fig. 1. A similar blower to the one on the right is connected to the left-hand end of the complete unit. It will be seen that two of the four bearings on the machine are on the turbine. Each end of the turbine shaft is flanged outside its bearings and is bolted directly to the blower shaft. Since the shafts are of large diameter, neither the blowers nor turbine go through their critical speed. Lubrication of the bearing is by a pressure oiling system.

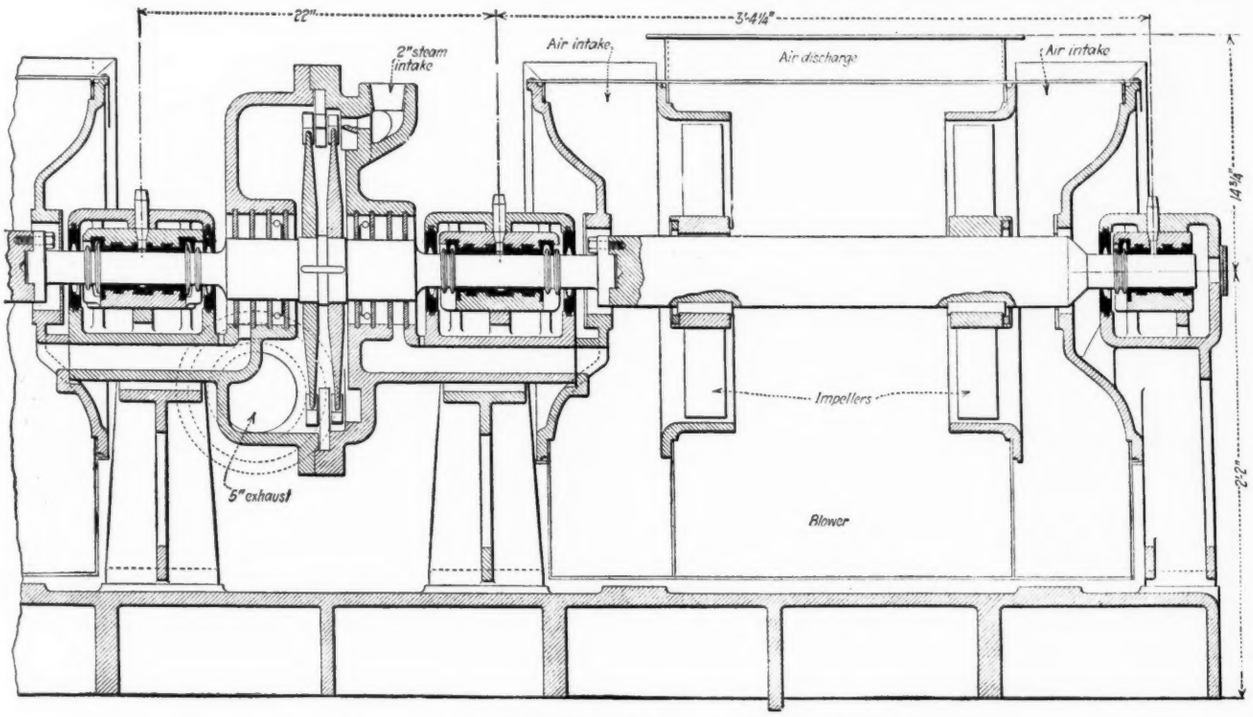


FIG. 1. CROSS-SECTION THROUGH TURBINE AND BLOWER

Two wheels, with impulse blading operating in series, are used in the turbine. With steam of 150 lb. gage at the turbine throttle and a small amount of superheat the steam consumption will remain practically constant at 2,800 lb., when the air conditions of the blowers are varied from 20,000 cu.ft. of free air per minute compressed to about 9 in. of water, to 35,000 cu.ft. compressed to 4.5 in. The most economical load with the steam condition is obtained at 27,500 cu.ft., compressed to 6.75 in. of water. When the steam pressure is reduced to 60 lb. at the turbine throttle, the steam consumption will be approximately 1,100 lb. per hour. and the volume of free air will vary from 7,500 cu.ft. per min. delivered at 4.25 in. of water to 22,500 cu.ft. per min. delivered at 1 in., the most economical point being 16,000 cu.ft. of free air delivered at 2.5 inches.

The blower wheels are made of phosphor bronze, pressed and keyed on the shaft. Special construction is used to take care of the difference in expansion between the shaft and impeller caused by the high gas temperatures, and prevents the latter from becoming loose on the shaft when the blowers are used for induced-draft purposes. Since the characteristics of the blowers are such that when the discharge opening is reduced the

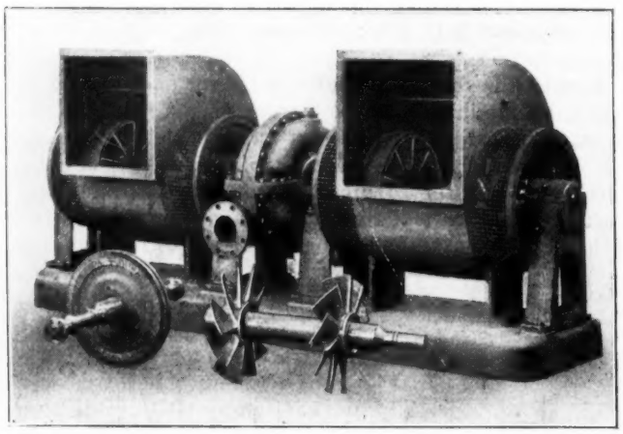


FIG. 2. TURBO-BLOWER ARRANGED FOR FORCED-DRAFT APPLICATIONS

air pressure goes up in a proportion that maintains the power consumption on the turbine practically constant, no governor is required on the turbine and its speed remains practically constant. This characteristic is a desirable one in forced-draft applications, since when the fire develops conditions that tend to reduce the air supply, the blower pressure increases automatically and tends to maintain the air volume constant.

A Correction

On Fig. 1 in the article "Boiler Capacities Obtainable per Cubic Foot of Furnace Volume," published on page 171 Jan. 31 issue, the curve of "Draft Losses Through the Boiler" is plotted against inches of water and the scale used being such that there is a loss of approximately 5 in. of water through the boiler when running at 300 per cent rating. This curve should have been plotted against decimals of an inch of water and run from 0.0 to 0.5, and not in total inches as shown. In other words the draft loss curve, in Fig. 1, shows losses 10 times as high as they should be.

How do French turbine designers get or expect to get high efficiencies with a small number of stages? It is said that the American bidders for the construction of the 40,000-kw. turbines for the new station at Gennevilliers, near Paris, proposed to furnish a 22-stage machine for 320-lb. pressure, whereas the French builders, who got the order, presented designs with only 10 stages and higher guaranteed efficiency. The guarantees for the Schneider turbines are 9.6 lb. per kw.-hr. at 313 lb., and a total temperature of 707 deg. F. at 35,000 kw. capacity. The machines are of the simple straight-flow type.

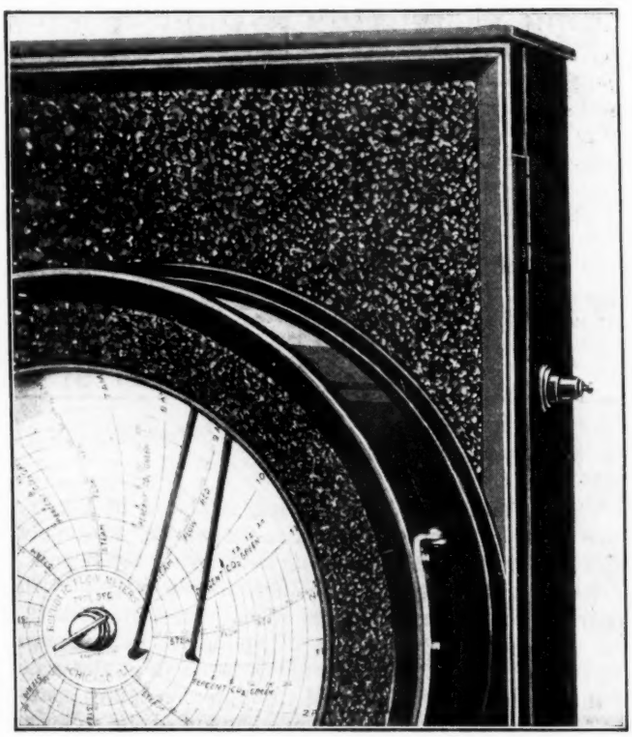
When a newly fitted brass is put into hard service, a little tallow in the clearances helps to prevent heating of the bearing.

Republic Steam-Flow Meter and CO_2 Recorder Combined

In line with the present tendency to centralize the control of boiler operation, the Republic Flow Meter Co. has combined its standard CO_2 recorder with its steam-flow meter in such a way that the two records are made simultaneously on the same chart. It is felt that the two factors of steam flow and CO_2 are the most accurate guides in running the boiler efficiently, and having two records on one chart makes it easier to keep track of both.

The CO_2 recorder shows the performance of the furnace in burning the fuel, and the flow meter shows the performance of the boiler in generating the steam. Maintaining the proper balance between the CO_2 and the steam flow, of course, makes for uniformly high efficiency, and the operator finds it easier to obtain this when he can concentrate his attention upon the one instrument and still keep track of both factors. Another point is that with separate instruments, when it is necessary to force a boiler at a high rating, the operator is likely to pay more attention to the flow meter and to neglect the CO_2 recorder, with the result that the demand for steam is met at the sacrifice of economy. With the combined instrument the operator cannot help seeing the CO_2 record when he is watching the steam flow and is therefore more likely to pay some attention to economical operation.

The combination of the two instruments was accomplished by mounting the electrical recording part of the



STEAM FLOW AND CO_2 RECORDED ON ONE CHART

flow meter upon the door of the CO_2 recorder. The wires from the flow meter body are connected to suitable terminals on the side of the recorder case. As may be seen in the accompanying photograph, which shows part of the new instrument, the two recording arms are so shaped that the points can pass each other on the paper, although they come together close enough to meet practical requirements of accuracy.

EDITORIALS

Apparent Cost Versus Actual Cost

IF A direct-current motor is installed that is too large for the load that it is to drive, about the only objectionable feature is the higher first cost of the motor and control equipment and the larger size of connecting wire required. This higher first cost is, at least partly, compensated for by the more constant voltage maintained at the motor terminals, due to the large line copper, and the motor should give better service and have lower maintenance charges than a machine operating under full load.

With an induction motor too large for the load it is to drive, not only is the first cost of the installation higher than that for the proper-sized machines, but also the power factor is lower, and the latter makes its bad effects manifest all over the system. In this case not only must the line conductors be larger, but the transformer and generator capacity must be greater than would be required for a motor of the correct size. An induction motor loaded to where its power factor is only fifty per cent, will require approximately one hundred per cent more current than a motor of the proper size to drive the same load, which means one hundred per cent more transformer and generator capacity. This is a very important feature to keep in mind when comparing the cost of a synchronous motor with that of an induction-type.

It is true that when only the cost of the motors is considered, the synchronous type is at a distinct disadvantage in the small and medium-sized high-speed machines when compared with the induction type. But the cost of the motors may represent only a small part of the total for the motor installation. If the induction machine is operated under its best conditions, its power factor will not be more than eighty-five per cent, and in actual practice this is the exception rather than the rule. Therefore at least about twenty per cent more transformer and generator capacity will be required than the rating of the motor. If a synchronous motor is installed and operated only at unity power factor, unless the power factor of the system is high, the required generator and transformer capacity to serve the motor will not exceed the capacity of the motor, and in many cases it will be less.

If the synchronous motor is used for power-factor correction purposes as well as to drive mechanical load, there are many cases where it can be added to the system and the power factor improved to such an extent that the transformer and generator capacity relieved by the reduction of the system's lagging wattless current is sufficient to supply the power load of the motor. Consequently, no additional capacity is required and the voltage regulation of the system will be materially improved. Furthermore, if the motor is driving a variable load, under light load conditions, on most industrial loads the induction motor lowers the power factor of the system, where the synchronous motor will improve conditions. Therefore it is evident that not only the cost of the motor should be considered, but also the additional capacity required in the generators and transformers. If this is done, the synchronous motors will be found to be able to compete with the induction type, in many installations, whereas if only the cost of the motors is considered it is at a disadvantage.

Banking Boilers

IT IS frequently the practice in power plants subject to wide variations of load during the day, to add to or take boilers off the line merely by the arbitrary judgment of the chief operator concerning the demand for steam. It is now becoming apparent that the demands for higher plant efficiency do not permit such arbitrary handling of these units. The subject of banked boilers is now one of close study to determine the true effects of banking on over-all plant economy.

Where modern stokers and furnaces have been installed, it is possible to carry heavy overloads without much loss in efficiency. The efficiency curves of such boilers, as determined by test, should be available to aid in judging correct operation. The problem then is to determine at how small a load it is profitable to allow the boiler to remain on the line and at what load this boiler should be banked and allowed to go out of service.

A banked boiler is one whose steam pressure is allowed to drop below main-line pressure and whose fire has been reduced by cutting off draft until only sufficient combustion takes place to keep the fire bed ignited. In the first place the furnace walls and arches give up their heat to the boiler on banking and are cooled down far below normal operating temperatures. Obviously, considerable coal will be consumed when the boiler is put on the line again in heating up the brick setting to normal temperatures. This is not an insignificant amount of coal, for it is said that in one of the largest central stations it takes one and one-half hours after cutting in a banked boiler after twelve hours' idleness before the walls are fully heated again.

Boiler-efficiency curves usually show highest economy at or slightly above the normal rating of the boiler. At first sight it would therefore appear profitable to allow the boiler to remain on the line under loads down to, say, sixty per cent rating before banking. This conclusion, however, does not consider the stoker auxiliaries. If a forced-draft fan is provided, it must be capable of handling the highest overload, say, three hundred per cent of boiler rating. At 75 per cent of rating it is operating at, say, one-quarter load. The fan efficiency will be low and the efficiency of the driving engine or turbine will also be low. Hence, the proportion of steam used by stoker auxiliaries at the lighter loads may be a disproportionate amount of the steam produced.

Instead of using an efficiency curve of the boiler alone, the curve should indicate combined efficiency of the boiler and stoker with all their accompanying auxiliaries, such as fans, stoker drives, etc. With such information available, and with data on banking and reheating-of-setting losses, it will be possible to deter-

mine the economical low load at which the boiler can still be kept on the line. Furthermore, one can then intelligently schedule the order in which a group of boilers may be banked instead of cutting them all off at once and throwing a heavy load on those remaining on the line.

Complete Muscle Shoals Power Development

THE Secretary of War in transmitting Mr. Ford's proposal to Congress left it entirely to our national legislators to determine whether the merits of that proposition justify acceptance or not. However, the Secretary leaves no doubt as to his opinion regarding the completion of the power development at Muscle Shoals. He states his position unequivocally as follows:

> If Mr. Ford's proposal be not accepted, it is my opinion that Dam No. 2 (Wilson Dam) should be completed by the Government, and that the power requirements for commercial purposes, the benefits to navigation, as well as the possible needs of the Government would warrant this expenditure.

There is, in fact, no doubt that completion of this power project together with reasonable development of water storage and other power facilities on the upper Tennessee, will result in the finest water-power development, from the viewpoint of capacity and low cost, which can be made available by any feasible development that can be quickly undertaken and completed.

The Government has spent at this point about seventeen million dollars and has the project approximately thirty per cent complete. The estimated cost for completion depends somewhat upon whether the work is to be done by the Government or by private agencies. It is probable that the cost in either event would not materially exceed twenty-five million additional for this dam, the power-house installation of five hundred thousand or six hundred thousand horsepower and locks and operating accessories for improvement of navigation at this point and for about fifteen miles up the river. The estimates of the army engineers have been conservatively taken and are intended to cover such construction difficulties as may be caused by unexpected floods of the river.

The Secretary does well to point out that such a project has a large bearing upon problems of unemployment at this time. To this he might well have added that it will introduce also an element of encouragement to industrial power users to know that the Government is going forward in the provision of power of low cost at a point which promises to be a very important industrial center of the South.

These points are independent of the considerations that are before Congress regarding the acceptance of the Muscle Shoals offer by Mr. Ford or the more recent offer made by the Alabama Power Company, but they form a sound basis for judging one important consideration of these offers; namely, they establish the fact that this power development is on general principles wholly justified at this time as a matter of engineering economics. There remains then only the question as to whether Mr. Ford should be privileged to do the development work, utilizing the power in the industries he would build up, whether the public utility should assume the initiative and build up an industrial load, or whether the Government should reserve to itself this responsibility.

Bleeding Reciprocating Engines

THE use of the bleeder-type steam turbine is by no means new, and many of these machines have been installed in industrial plants where process steam at several pounds pressure is required. The field of the bleeder turbine has also been extended to embrace the heating of the boiler-feed water by bleeding one or more of the turbine stages.

Professor Stumpf has proposed and built a unaflow steam engine embodying the same principles of taking off steam at a pressure much above the terminal or back pressure. This may be secured in the unaflow by the employment of tapped openings in the cylinder barrel, which ports are uncovered by the piston. A certain amount of low-pressure steam may then be discharged through these openings until the lowered cylinder pressure is insufficient to keep the spring-loaded check valves open. On the compression stroke a part of the compression steam may also be drawn off.

It would seem that this principle might well be adapted to reciprocating engines of almost any type. The counterflow engine does not have the advantage of the long unaflow piston, but the bleeder pressure may well be controlled for high and low values by proper regulating valves.

This combination should be of extreme advantage in industrial plants where refrigeration is required. By bleeding steam at a comparatively high pressure, an absorption refrigerating system could be operated over its most efficient range and would in many instances be more economical than a compression system and should be cheaper to install.

That steam of moderate pressures is essential for absorption systems operating over certain temperature ranges is understood. To provide this steam without throttling from a high-pressure boiler, has been the subject of considerable investigation. At present one prominent refrigerating engineer has a system whereby part of the exhaust from an engine is compressed in a separate cylinder to the pressure needed by the absorption systems. The bleeding process here outlined apparently is simpler and more economical.

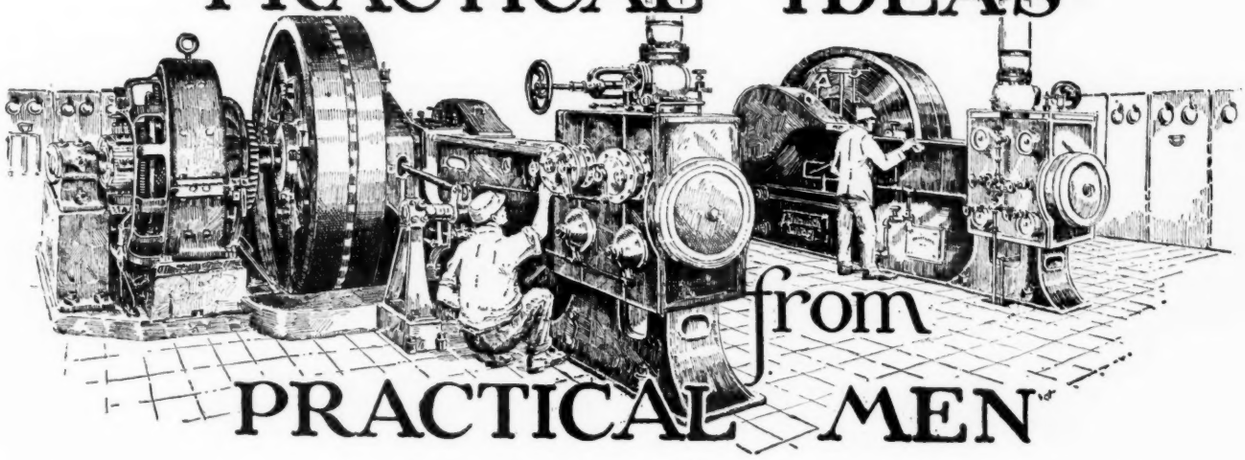
Engineers using reciprocating engines should investigate all methods that offer opportunities of making greater use of the steam passing through the engine.

When the Federated American Engineering Societies came into existence last year, the American Society of Civil Engineers was one of a few engineers' organizations that stayed out. The society's action was regarded at that time as being somewhat reactionary, and hope was expressed that it would be reconsidered at a later date. While such reconsideration may or may not be on its way, it is a significant fact that the Washington Section of the society, at its meeting February 3, by unanimous vote, expressed its desire to become affiliated with the Federated American Engineering Societies.

Henry Ford's recent reduction of thirty-seven per cent in the price of his farm tractor scarcely indicates that he would be unfair to the farmers if given control of the Muscle Shoals plants.

An advertiser in a Philadelphia paper wants an "engineer," "one with knowledge of running an automobile truck." Does he want an engineer or an "engineman"?

PRACTICAL IDEAS from PRACTICAL MEN



Suggestion Box for the Power Plant

The suggestion idea has been in use many years and has proved of mutual advantage when handled fairly and promptly. If the chief is big enough, he will admit that a suggestion box might tend to turn his force into efficient men. In many plants the chief laughs when suggestions are mentioned, but in manufacturing plants the employees think about possible improvements. A few examples of the working of a suggestion system in a power plant are outlined in the following:

A large manufacturing company at Akron, Ohio, has used a suggestion system for many years with marked success, and many troubles have been remedied in the power-house operation as well as in the factory.

During 1919 and 1920, when production swung into unprecedented peaks, the men in charge of the power house were kept busy supplying power and could not be expected to watch with normal carefulness the leaks between the coal pile and the switchboard.

Grate bars in the stokers were being burned out at a fairly steady rate. Under the conditions this expense did not seem excessive, and no investigation was made. However, a fireman sent in the suggestion that in his opinion the burning of these grates was due to the air passing through the grates in a restricted area. His remedy was to install a series of baffles in the air chamber in order to give an even distribution of the air to the grates.

Upon investigation, reference to the purchasing-department records showed startling expenditure for grate bars during the preceding six months. A trial installation of the baffles was made on one boiler and after a test of several months with no replacements necessary, the suggestion was officially adopted and an award in cash, based on the saving effected, was paid to the fireman.

Another case which showed the fireman had a good working knowledge of the action of high temperatures on different materials was that when certain of the boilers were down for cleaning or repair, it was repeatedly found that the supports of the baffle had warped, allowing the baffle to drop and expose a seam on the drum. Different repairs had been tried without eliminating the trouble. A suggestion by the fireman resulted in the adoption of a practical method of supporting the baffle with the supports properly protected from the hot gases, and a trial proved conclusively that with the new design the baffles remained in position and gave no further trouble.

Similar cases go to prove that the engineer benefits himself as well as the company by encouraging the men in the boiler or engine room to take advantage of suggestion plans provided for employees. The best way for a chief to help and encourage his men is to discuss frankly with them any ideas they may advance.

Lafayette, Ind. DUDLEY P. CRAIG.

Light, Heat and Power

Did it ever occur to you that you can do many important things in a highly creditable manner which any other man in the same walk of life can do.

If two men each had similar labors to perform, one working in a good light and the other working in the dark, you will admit that the one working in the light would do work of higher quality.

As learning lightens labor, every man, young or old, should look for all the light he can get on the subject of his calling. He may start with a single candlepower, but if he will continue to search for the light of learning pertaining to his trade, business or profession, he will be surprised to find his light becoming in time a searchlight of high candlepower.

Then go out in the light, attend the many good meetings and lectures of the engineering societies and read the leading publications pertaining to your calling.

When you begin to get the light, then help generate the heat, the enthusiasm of expansion; it is the band that plays for and leads the march of progress, so do your part in keeping up the heat of success.

With the proper use of light and heat comes the power to push onward and upward, the power to furnish light for others and help them into the ranks of the progressive plodders. It is the power that makes you a worth-while wheel in the machine of which you are a part.

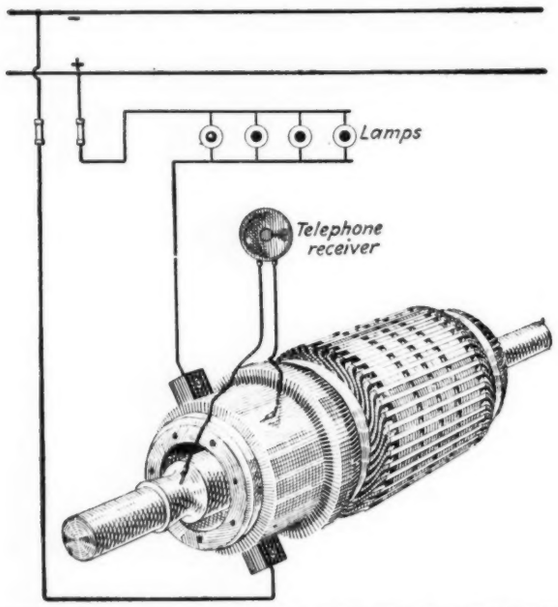
It is said that an organization of men is like a machine composed of a multiplicity of parts, the success of the whole depending on the smooth operation of each part. Final or combined efficiency depends on the efficiency of individuals or individual parts.

If you have the light of learning, the heat of enthusiasm and the power of application, your circuit breaker will not come out. J. A. SNYDER.

Pittsburgh, Pa.

Localizing Armature Ground-Faults

Frequently, when investigating a grounded armature, much time can be saved if the ground fault can be located with respect to the commutator bar to which it is nearest. When this is done, it is a matter of only a few minutes to raise the leads from the bar or bars where the fault has been found and determine with a



CONNECTION FOR LOCATING GROUND IN ARMATURE WITH TELEPHONE RECEIVER

test circuit whether the defect is in the winding or in the commutator. A simple test for locating the bar nearest to the ground can be made with a telephone receiver, as indicated in the figure.

A direct current is passed through the armature by brushes disposed as they are in the machine in which the armature operates. The value of this current will depend on the size of the machine, but should be of a strength to give a good click in the receiver. One test line from the telephone receiver is held on the armature shaft, and the other test line is touched to the commutator from bar to bar until the point of silence or of minimum intensity of sound is reached by the exploring line.

This bar is the one on which the ground is, or to which the defective coil connects. If alternating current is available for passing through the armature, the test point need not be made and broken with the bar because a continuous hum will be emitted by the receiver excepting when a point of silence may have been found. Ordinarily, there will be no point of absolute silence, but the intensity of the buzzing will be greatly reduced and easily discernible to the ear.

The test is an old one and is easy to make, and it does not cost much to get facilities for doing the work. The main precaution conducive to success is that the current sent through the armature be of sufficient value to give a vigorous indication in the receiver. The test should be repeated for two or more positions of the armature, and in each case the point of minimum noise in the receiver should be the same in all cases. If there are two points of minimum noise, this indicates the presence of two or more ground faults.

Brooklyn, N. Y. E. C. PARHAM.

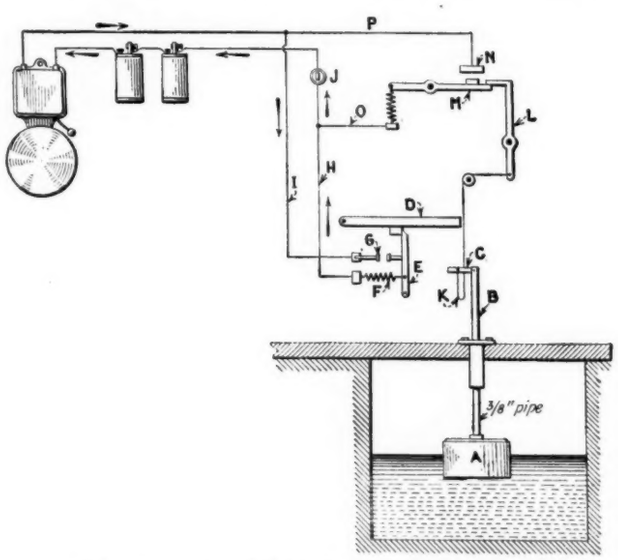
Alarm for High and Low Sump Water

Although in many plants the sump pump is arranged to start and stop automatically, it is not so in my plant. It is almost impossible to get the men to pay much attention to the sump water, and it was either full or the pump was allowed to run until the sump was empty, when the pump would call attention to the fact by its action, and running with an empty suction does not improve a pump. After the pump had been allowed to run away several times, it was decided to install some sort of signaling system, and so one was rigged for both high and low water.

First, a float *A* for the sump was secured to a ⅜-in. brass rod *B* that projected above the boiler-room floor, passing through a pipe that was secured to a floor plate to steady it. A piece of brass *C* was riveted at a right angle to the rod *B* and is for tripping the high and low contact levers *D* and *L*. The alarm system is arranged as shown by the illustration.

When the water rises in the sump, the float *A* and rod *B* rise also until the offset *C* strikes the contact lever *D*, which is pivoted at the other end, and lifts the free end so that the catch block releases the arm *E*; and the spring *F* pulls the contact arm *E* toward the left, making a contact at *G*. This closes the circuit through the bell in the direction of the arrows through the wires *H* and *I*. The switch *J* can then be opened to stop the ringing of the bell and the pump started to clear the sump. After the water has been pumped out sufficiently, the trip *D* is reset and the switch *J* thrown to the closed-circuit position.

After the water is pumped out to a predetermined point, the float *A* pulls the cord *K* until it is tight enough to move the bottom end of the lever *L* toward the left and release the contact arm *M*, the spring of



WIRING AND CONTACTS FOR SUMP ALARM

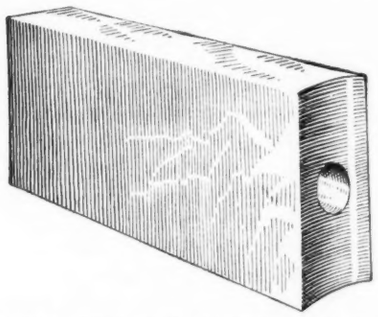
which causes the contact end to make connection with *N*, thus closing a circuit through the bell and wires *O* and *P* in the directoin of the arrows. The attendant then stops the pump and resets the low-water contact when the high-water alarm again rings.

Although the system depends upon the human element, it is giving good service and has prevented racing of the pump and also an overflowing sump.

St. Louis, Mo. P. LOWERY.

Preventing Chattering of Brushes

Most every electrician and operating engineer has had trouble with chattering brushes, and applying lubrication to the commutator only gave temporary relief—the chattering would invariably come back. I have found that boring a hole in the center of the brush face has been effective in eliminating chattering in a number of cases. The hole is made in diameter about one-half the thickness of the brush and extends into it about ¼ in. deep.



SHOWS WHERE HOLE WAS BORED IN FACE OF BRUSH

I am unable to give a satisfactory explanation why this should stop the chattering, but it does the trick and this is the chief concern. It may be that the hole changes the co-efficient of friction of the brush sufficiently to remove the trouble. W. ANDERSON.

Boston, Mass.

Safety in Tagging Valves

Considerable stress is placed on the importance of tagging, disconnecting and grounding, under proper supervision, the electrical apparatus in the power plant so as to protect the workmen. Then why should not the operation of steam, air, vacuum and water-pipe lines be placed under the supervision of a responsible person?

When an electrical line is to be examined or repaired, it is designated by letter or number. What is to prevent placing a suitable piping diagram in the care of a responsible man and also putting under his directions the various lines sectionalized and tagged in a manner similar to that used in the electrical division? Such a man would act as dispatcher, and thus would eliminate the confusion that generally precedes complicated by-passing or cutting out of service apparatus to be repaired.

Except in cases of emergency no valve could be opened or closed unless ordered by this person. Also, when a man finished working he would report "clear" to the dispatcher, who would direct the opening and closing of valves to put the lines normal.

Valves to be manipulated with the aid of numbers would be tagged, for example, as follows: H. S. 24 would indicate high-pressure steam, followed by the number of the valve, or all numbers beginning with No. 1 would indicate that it was used for steam; those beginning with the No. 2 would indicate that it was on exhaust steam. Different installations would require different methods of indication.

In the event of tagging such valves, I might suggest that two kinds of tags be used, red and green. A red tag placed on the valve might indicate that it could not be opened except on order of the supervisor; a green tag, that it could be opened only by order of the person whose name is on the tag, or by order of the supervisor. This would allow the repairman to test such apparatus as he had overhauled.

In many plants the color system is used to advantage. The color of the pipe or trimmings indicates the class of work for which used. Such a scheme is out of the question in small or moderate-sized plants.

Of course the plan need not be as elaborate as explained here. The main point is the numbering of the valves. I would be pleased to hear from readers of *Power* as to their experience in this line of safety engineering. CLEMENT P. COREY.

Uxbridge, Mass.

Suggests Arrangement of Feed-Water Piping for Three Boilers

Directions for piping the front of a battery of three boilers have been published and widely circulated by what appears to be, and generally is, a competent authority on such matters. However, the subject is open for discussion. It is possible to operate a battery when so piped, but it is not the best plan that can be devised, hence I hope to present a much better one, with reasons for the suggested improvements.

The original piping of the three boilers is shown in Fig. 1. The feed pipe *A* is of one size. *B* is a brass union, *C* is a swing-check valve, *D* is a gate valve and *E* is an ordinary ell. The water columns have no high- and low-water alarms, and there are no valves in the connections between them and the boilers. The steam gage is attached to the top of the water column as shown.

I suggest the following improvements as illustrated in Fig. 2. The feed pipe is 3 in. in diameter where it delivers into the first tee *F*. From the first to the second tee for the second boiler it is 2½ in., and from the second to the third it is 2 in. These sizes are more suitable, for the quantity of water delivered than any one size can be, and it will tend to give an even feed for all the boilers. The tee *F* is 3 x 2½ x 1½ in., without bushings. Bushings are always weak points and frequently they are not threaded with proper care, hence it is difficult to make the pipes either straight on the line or square on the outlets. The tee for the second boiler is 2½ x 2 x 1½ in. and for the third boiler

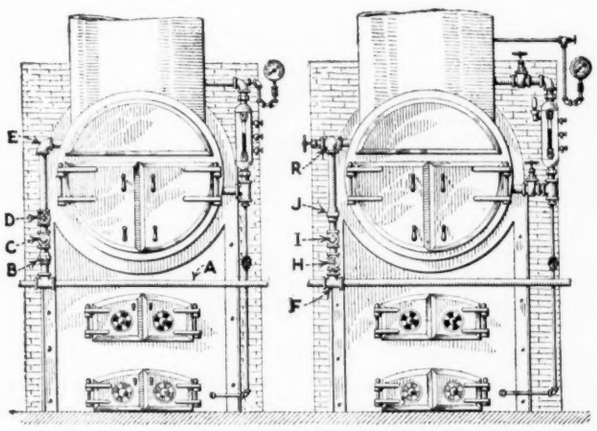


FIG. 1. ORIGINAL FEED-WATER PIPING

FIG. 2. PROPOSED FEED-WATER PIPING

it is 2 x 2 x 1½ in. A tee is used on the third boiler rather than an ell, as at *F*, Fig. 2, as it may be convenient to remove the plug to inspect and clean the pipe.

A gate valve is shown at *H* and a vertical check valve at *I*, a union at *J*, and an angle valve at *K*. A swing-check valve in a vertical pipe is a bad idea, as it may or may not close properly, and it is likely to leak. A vertical check valve is much better. By closing *H* and *R* it is possible to adjust or repair *I* and *J* while feeding the other boilers, and without removing the pressure from the one that is directly affected. The stem of the valve *R* can be packed at any time by closing it and the valve *H*. The water columns are fitted with a high-water alarm to protect the engine and a low-water whistle to safeguard the boiler.

Why should a water column be used without both the high- and low-water alarm? Inquiry was made of a boiler-insurance company concerning their objections to these safeguards, to which the reply was made that their only objection was to the high-water alarm. On one occasion a fireman heard a whistle blow and at once concluded that there was too much water in the boiler. He opened the blowoff valve and waited for the whistle to stop, but it continued to blow. Investigation showed that it started to blow for low water, and it continued to blow until normal conditions were restored.

This does not appear to be sufficient cause for eliminating all high-water alarms. The human element must always be a factor in such cases, hence if any appliance is mismanaged it will not work properly. If all improvements were discarded on this account, it would be a long step backward.

The fronts of my boilers are not visible from the engine room, and the supply of water is not always controlled by the firemen, as the returns must be taken care of, even if they are not actually wanted in the boilers. It is, therefore, of advantage to have a high-water indicator.

Ignorant firemen sometimes adopt the practice of doing two things—pumping water into a boiler until the high-water whistle blows, and stopping the pump until the low-water alarm sounds. Under such conditions it is an easy matter to wreck an engine or ruin a boiler, provided a certain type of alarm is used. With a plain water column a careful fireman will keep his water level within certain limits, and the same practice should be followed where more modern appliances are used. The whistles will then blow only under abnormal conditions, as they were intended to do.

The principal cause of trouble that I have with the six water columns installed in my plant, is water-logged floats. Observe the result. When the lower one becomes filled with water, the low-water alarm blows continuously. Is there danger of failing to know when it needs attention? Of course, the low-water alarm is of more importance than the other. If the upper one fails to operate, it does not endanger the boiler, and the water level must rise far above the top of the glass before it can damage the engine. Such alarms have undoubtedly prevented trouble many times.

The water columns are fitted with a gate valve in both bottom and top boiler connections. I have read several statements which condemn this practice, but every one of them is inconsistent as long as the use of valves in the glass gage is permitted, because a fireman can shut these valves when the glass is partly filled with water, and then proceed to draw all the water out of the boiler, but it will still show in the glass. Has anybody advocated the use of glass gages without valves on water columns that cannot be shut off from the boilers?

In thousands of plants, even though the water glass was shut off, the whistle would give the alarm if there was too much or too little water in the boiler. What would happen if only a plain water column was installed?

When a writer disapproves of valves in water-column connections, he only points out what might or what has happened because of their use, and never states the advantages of having them installed. Twenty-seven years ago I began to use water columns with valves in the connections, but only shut off the gage glass at night. Before morning I was called to go down to the boiler room and stop a whistle from blowing. The fires were banked, and there was too much water in this boiler. I have not been called for that purpose since.

The steam gage should be piped to a steam outlet connection of the boiler, because closing the gate valve shuts it off from the boiler if connected as in Fig. 1. Carry the pipe directly to some point where it cannot be shut off. An angle valve will permit the gage to be shut off independently when occasion arises that requires it.

The drip pipes from the columns may discharge into the ashpits, but it is better to lay a pipe under the floor and connect all drips to it.

W. H. WAKEMAN.

New Haven, Conn.

Stopping an Ammonia Leak

While the larger refrigerating plants are usually provided with safety helmets for use in case of serious ammonia leaks, small plants are seldom so equipped, and even in large plants the helmets are sometimes allowed to get out of order. For this reason the recital of what I did in one plant may assist some engineer on a like occasion.

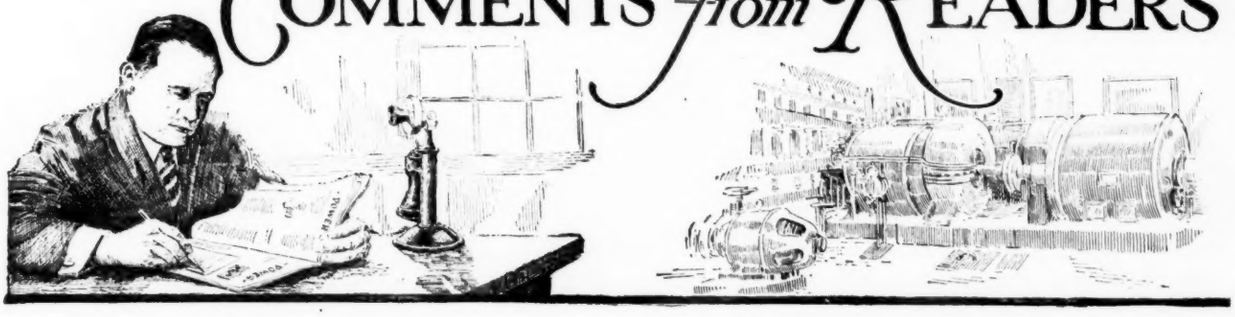
In a refrigerating plant where gas-engine-driven compressors of 80-ton capacity were installed, a slug of liquid ammonia caused a gasket to blow out on the crank-end head of the compressor. The engine room was soon full of fumes, the other machines were still running and no helmets were in the plant. The engineer called up my employers and I was sent to the plant to see what could be done.

When I got there it was impossible to enter it on account of the fumes which filled not only the building, but the street outside. I got all the information possible from the engineer as to the location of the valves and the particular machine that was leaking, there being three machines in the plant. I then secured a quart of vinegar and after saturating heavy towels with it, wrapped these towels over my mouth and nose. After three attempts I managed to get the suction valve closed, and followed this up by closing the discharge valve. The engines were then shut down, and since there was a brisk wind blowing, the plant was soon cleared of ammonia fumes.

We then removed the piston and cylinder head and replaced the rubber gasket, which had sprung a leak, by one which we cut from a sheet of lead. We then reassembled the compressor and repacked the piston-rod stuffing box and started up after a shutdown of but seven hours and with only a small loss of ammonia.

New York City. D. L. FAGNAN.

COMMENTS from READERS



Utilizing Flue Gas To Preheat Air to Furnace

With the greatest respect for the contributors and editors of *Power*, I would like to offer some criticisms of the article, "Utilizing Flue Gas to Preheat Air to Furnace," by E. R. Welles and C. T. Mitchell in the issue of Nov. 29, 1921.

In connection with Scotch boilers in marine work, the Howden System of forced draft is a well-known application of the idea proposed by Messrs. Welles and Mitchell as a new method of increasing boiler and furnace efficiency. In this system the flue gas is led through a nest of tubes two or three inches in diameter and about four feet long. These tubes are usually made of No. 12 or No. 14 B.w.g. plate and are set vertically. The air for combustion is forced across the tubes and then led to the ashpits at a temperature seldom above 250 deg. F.

The figures are from Sterling's "Marine Engineers Handbook," in which, however, no values are given of the temperatures of the flue gases leaving the heater. The high flue-gas temperatures that are met with in Scotch-boiler operation favor the use of such an apparatus, but its value in connection with water-tube boilers and their lower gas temperatures would at least seem doubtful.

In the actual design of an air preheater the use of a true counter-flow apparatus would offer considerable difficulty. If the air is allowed to flow along the tubes, there will, of course, be a tendency toward stratification, with its accompanying decrease in the efficiency of the apparatus. This may be overcome by maintaining a velocity above the critical velocity and so obtaining a thorough mixture. Another solution would be the use of baffles or "retarders" of some form. Either of these would mean increased resistance and, therefore, more work for the draft fan.

Probably the most satisfactory design would be along the lines of the Howden System; that is, forcing the air across tubes through which the flue gases travel. Such an arrangement is far from being a counter-flow apparatus, and a mathematical treatment of it would become too complicated for practical use. The first row of tubes over which the air passed would be much the most efficient, and the succeeding rows would become of less and less value toward the discharge end of the heater. Any strictly logical treatment must therefore consider each row separately with due regard to the fact that only a part of the flue gas is involved. In such a case the logarithmic mean temperature must be used, and the computations are still further complicated by the uncertainty as to just how much of the tube surface is in contact with the moving air. The problem might be solved approximately by assuming an arithmetical mean temperature difference and an average value of K for the entire stack.

A somewhat better apparatus might be designed by using two, three or more passes for the flue gas, similar to the usual arrangement for circulating water in a surface condenser.

A limit to the returns from an air preheater lies in the lowest allowable flue-gas temperature. The gas must not be cooled to the point where its contained moisture begins to condense. The difficulties of "sweating" tubes, which offer such a problem in the case of cast iron, as used in economizer tubes, would, of course, be more important in connection with wrought iron or steel construction.

These criticisms are offered, not with the idea of condemning the air preheater, but rather to point out some of the difficulties, and so possibly suggest profitable lines of investigation. The writer must confess that he believes such an apparatus would result in a net saving in only a few cases. On the other hand, it is not so very many years since even a feed-water heater was considered more or less of a luxury.

Wollaston, Mass. DEWITT M. TAYLOR.

Why the Radiators Would Not Heat

I was especially interested in the article, "Why Radiators Would Not Heat," page 151 of the Jan. 24 issue, as we have had similar troubles, evidently because the trap that was supposed to drain the main riser failed to do its work.

It is possible that the trap to which Mr. Sheehan refers is of the expansion type and will remain open until the temperature is around 190 or 200 deg., when it will close and will not open again until the water drops below that temperature.

With the trap closed close to the main and with steam turned on, the water will probably remain at or near 212 deg. in the main, due to a little steam gradually bubbling up through it. The temperature of the water in the trap will remain nearly as high, as there would not be enough radiation to cool it enough to open the trap to drain as fast as the water collects in the main. When this happens, the main will eventually get enough water in it to stop the flow of steam. The remedy is to install a trap that will work on the float principle instead of with a change of temperature.

We had a case somewhat parallel to Mr. Sheehan's, with the exception that the building in which the trap was situated was so cold that the trap would freeze up at times, and the float would not operate until it thawed

out. To get around this automatically, we installed an expansion-type trap beside the float trap. This trap will always stand open when cold, and the warm water that flows through it before it closes up will thaw the ice in the float trap, which drains the main when it is hot.

The steamfitters' method of piping might work better if an expansion type of trap were used, as the water would have a chance to cool, and if the pipe to the trap was of sufficient length it would cool enough water to keep the main drained. HOWARD GLUYS.

Richmond, Ind.

Comments on Breakdown of 30,000-Kw. Turbine

The article in *Power* for Nov. 22, 1921, covering the investigation of the accident to a 30,000-kw. turbine of the Philadelphia Electric Co., has aroused a great deal of the disaster, either in the reports of Messrs. Moore agreement that the failure was caused by vibration, but no reference whatever is made to the underlying cause of the disaster, either in the reports of Messrs Moore and Kelley or in the discussion by Mr. Smoot, which appeared in the Dec. 27 issue of *Power*.

Professor Moore concludes that it was caused by the progressive fracture of a turbine disc fatigued by long-continued vibration. This implies the generally accepted theory of crystallization, regarding which the present writer wishes to call the reader's attention to an article by G. H. Gulliver on the "Effect of Vibration upon the Structure of Alloys."[1] Mr. Gulliver finds, as a result of his preliminary experiments, that vibration results in an increase in the average size of the crystal grain, which means a deterioration in the quality of the material.

No doubt Professor Moore's conclusion, that it was a progressive fracture which finally culminated in the destruction of the unit, is correct. But his theories as to what caused the vibration that resulted in the breakdown are inconclusive and surprising in view of the known condition of the unit in question. In this connection it might be pertinent to ask Messrs. Moore and Kelley whether they knew that this turbine vibrated badly; that it ran "rough," which was in fact well known to the operating staff, and even to some outsiders like the present writer; whether or not it was the practice, during the last few months, to open up the turbine on Sundays or holidays and to experiment by cut-and-try methods with trial weights in an endeavor to improve the balance. It surely was not old age that caused something to bend out of straight or to crystallize. Why should not plain ordinary "roughness"—in other words a bad vibration due to poor balance—be sufficient to explain the origin of the trouble? The sooner the operating fraternity learns that vibrations may readily lead to actual explosions, the safer it will be to run high-speed machinery. Indeed, no manufacturer would venture to pass upon the purchasing public a badly vibrating piece of mechanism if he knew that the acceptance tests would include not only performance, but also freedom from vibration at all speeds

Right here the writer would like to caution the reader against a pitfall; It often happens that at a certain speed the amplitude (swing, each way, from the neutral position) of the vibration is excessive, and as the speed increases the vibration subsides somewhat. *Don't conclude from this that the machine is safe to operate at higher speeds.* This may seem to be the case, but why should it? The cause of the vibration is still present and its destructive effects may be serious even though there is no visible manifestation of its presence, such as is so evident at the synchronous speed of the rotation with the free period of the support. Except at the speed of resonance the amplitude of the vibration, of which the most frequent cause is unbalance, either static or dynamic, is small, but the stresses may be large so that, ultimately, failure of the shaft may take place somewhat like in *A*, Fig. 4, page 789 of *Power* (Fig. 1 herewith).

As regards fluttering (axial vibrations of disks), did Messrs. Moore and Kelley know that in a certain power plant, two turbo-generators of a type similar to the one that failed, stood side by side, one being the spare unit;

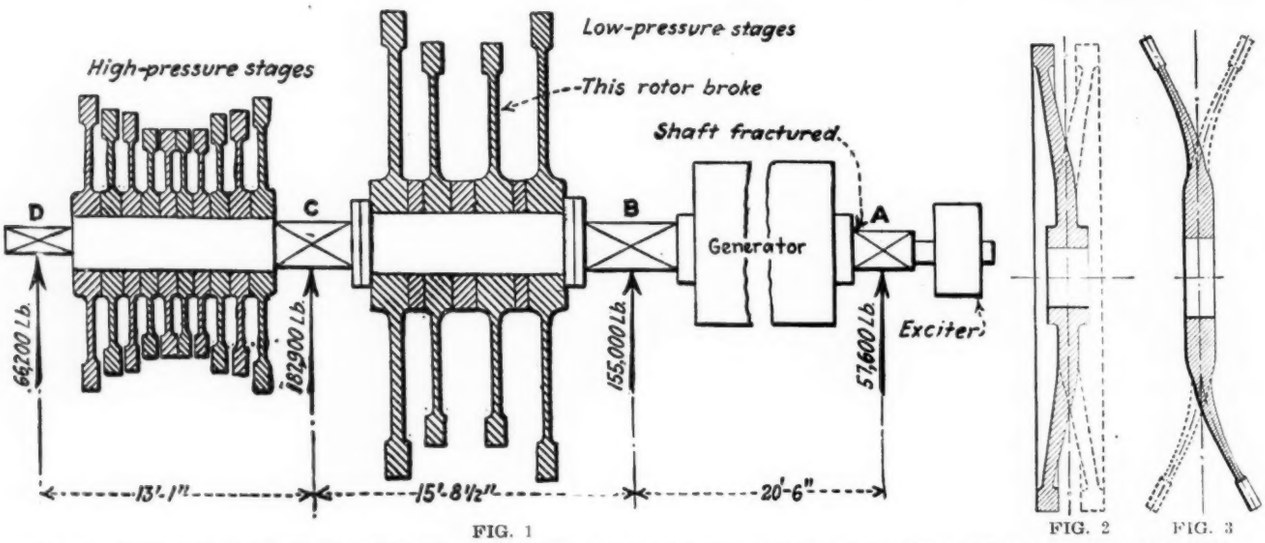


FIG. 1 FIG. 2 FIG. 3

FIG. 1. OUTLINE OF ROTOR, SHOWING RELATIVE LOCATION OF PARTS AND POINT OF FRACTURE OF 20-IN. SHAFT. FIG. 2. SHAPE OF TURBINE WHEEL WHEN RUNNING AT CRITICAL SPEED. FIG. 3. FLUTTERING OF A TURBINE DISC

[1] Proceedings of the Royal Society of Edinburgh, Vol. XXXII, Part III, No. 22.

that the disks in the turbine *shut down, with the casing taken off* fluttered excessively, when the other turbine was running, clearly indicating the propagation of the vibration through the common sub-foundation? This being the case (synchronism, pure and simple), what is the use of looking for a "tentative" explanation in the action of steam or in the fact that the turbine was "usually stopped and started every two days." Look at it any way you please, you will find the same thing: The rotor shook owing to defective balance; the reaction of the bearings was naturally of a very complex nature, sufficient to start vibrations of all sorts, including the axial (fluttering); and there is no necessity for looking for any other cause of trouble.

Incidentally, speaking of "fluttering," it might be mentioned that this phenomenon as a rule is very much misunderstood by the engineering public. Take, for instance Mr. Smoot's discussion (p. 1028 of *Power*) and you will see an example of the regrettable liberties that a practical man at times is likely to take with science. Mr. Smoot describes his own "method" of dealing with the question of vibration of circular disks. But how about Föppl and Lord Rayleigh and Love and other great masters who have worked this out in detail for us? Don't they count at all, or are their works "too difficult"? In studying vibrations of either beams or disks, we naturally start with a partial differential equation, and not with the ordinary differential equation of flexure, given by Mr. Smoot, which applies only to statics of beams. The correct differential equation leads to the conclusion that the disk can vibrate in two different ways, to which we shall return presently. We would only remark that the mode of vibration illustrated in Fig. 3 p. 1029 of *Power* (Fig. 2 herewith) by Mr. Smoot, is the one most unlikely to occur in practice, in view of the bucket rim and of the rather substantial hub.

As a general proposition the two so-called modes—that is, varieties of ways in which a disk of this sort can resonate—are:

1. With nodal diameters; in other words where there are one or more *diameters of rest* (corresponding to *points* of rest, nodes, in a vibrating string), about which the plate bends like in Fig. 3 (p. 1029) of Mr. Smoot's discussion. This mode of vibration would be more probable if we had a free boundary, whereas the actual case approximates one of clamped boundary. Furthermore, this mode is altogether improbable in a *rotating* body, in view of gyroscopic reactions that would be set up thereby; it is, however, not an impossible mode in a stationary disk.

2. With nodal circles (none, one, two or more, according to the frequency) suggesting the diaphragm of the aneroid barometer, or the surface of tea in a cup, rapped gently with a pencil. In this case we have circular *lines* of rest of varying number more or less pronounced, depending upon the frequency of the disturbance. In general, all are present at the same time, but at the frequency of resonance of one of them it will manifest itself prominently to the apparent suppression of the others. The fundamental mode of such a vibration, corresponding exactly to the case in which we are interested, is shown in Fig. 3.

Now, any arbitrary, persistent disturbance may encourage any one of these manners, in which the disk can vibrate, or any combination of these, depending upon the complexity of the disturbance itself. And right here the remark may be made that the disturbance caused by any combination of centrifugal forces and centrifugal couples commonly known as lack of balance, while periodic, is not necessarily simple harmonic, but is more likely to be of great complexity.

But then all this boils down to the same conclusion: If there is no disturbing agency—in other words if the balance is perfect—no synchronism can be experienced by the system, except possibly by such supersensitive instruments as, for instance the Frahm tachometer; otherwise the rotor will spin with that wholesome hum by which an experienced man will safely be in a position to predict that no old age or crystallization or occasional starting and stopping will cause the turbine to blow up.

During the last five years the writer, or his organization, has been instrumental in fixing up hundreds of matters of precisely this kind. There is no excuse for badly vibrating rotors, and any casualty in breakdowns of this kind cannot be called a regrettable accident of the "will of God" nature, but one which is preventable by ordinary precaution. The writer hopes that not only the operating man and the manager, but also the flywheel and casualty insurance man, will clearly understand just what this means.

N. W. AKIMOFF.

Philadelphia, Pa.

Simplifying Locating Troubles on Electric Circuits

I was much interested in Harold R. Hutchinson's comments on methods of construction that would simplify locating faults on electric circuits. The suggestion that branch circuits should be made to the main circuit so that they may be easily disconnected in case of trouble on the system is one that has been adopted in some cases in control circuit in power plants. The additional cost does not seem to warrant the adoption of such practice in general.

It would seem to be a more logical procedure to go to more expense in making the installation according to standard practice. Is not 90 per cent of the difficulty experienced on electric circuits due to poor construction? Pulling a spliced wire into a conduit is a violation of the National Board of Fire Underwriters' regulations and there are hundreds of examples that show this to be bad practice and that it invariably leads to trouble; still there are many who continue to do it. Another practice that is frequently indulged in, is pulling wires into a conduit that is too small for the circuit. This results in damage to the insulation on the conductors and a breakdown to ground at some future time. Failure to ream out the end of a conduit properly after it has been cut and threaded is another source of trouble. Failure to use proper fittings on the ends of conduits where the conductors come out, is always a prolific source of failure in electric circuits. Installing conduit in wet places so that any moisture that may find its way inside cannot drain out, is sure to lead to trouble.

Until we have ceased to do those things that invariably lead into trouble, in many cases to save on the expense, there seems to be no good reason to add more equipment to the circuits to help locate faults that never would have occurred if the job had only been done in a proper manner in the first place. What is wanted on the average electric circuit is better workmanship, and when this is brought up to the proper standard there will be little use for construction to help locate faults when they do occur.

Boston, Mass. CHARLES A. ARMSTRONG.

QUESTIONS AND ANSWERS

Delivery by Plunger Pump

What quantity of water would be discharged by a 4 x 10-in. plunger pump operating 60 strokes per minute with only ¾ length of stroke? H. H.

The displacement per stroke would be $4 \times 4 \times 0.7854 \times 10 \times \frac{3}{4} = 94.25$ cu.in., and without allowance for slippage the delivery would be $94.25 \times 60 \div 231 = 24.4$ U. S. gal. per minute.

Fan Capacity for Indirect Heating

Manufacturers' catalogs giving capacities of fans for indirect heating quote the delivery in cubic feet per minute of air at 70 deg. F. Suppose a room that contains 100,000 cu.ft. should have 4 air changes per hour, the fan would be required to handle $4 \times 100{,}000 \div 60 = 6{,}666$ cu.ft. of air per minute at 70 deg. F., but as the air passes through the fan at 130 deg. F., what should be the capacity of the fan? A. J. B.

For the same pressure the volume of a given weight of air varies directly as the absolute temperature, and delivery of 6,666 cu.ft. of air at 70 deg. F. per min. when at the temperature of 130 deg. F., would require a delivery of $6{,}666 \times \frac{130 + 460}{70 + 460}$ = about 7,420 cu.ft. per min., and that should be the actual capacity of the fan.

Economy of Coke as Steam Fuel

We are using both coal and coke in our plant, but are not quite sure which is more economical. What is their relative heat value for steaming purposes? R. M. C.

Dry coke usually contains about 60 per cent as many heat units per pound as the coal from which it is produced. On account of the cellular structure of coke the combustion usually is more complete and thereby a higher percentage of heat content is obtainable than from coal. The relative value of coke or coal for steaming purposes depends on the analyses of the fuels, the draft and furnace conditions. For a given plant the best method of ascertaining the relative economy of the fuels for steaming would be to determine the cost of each kind of fuel required per 1,000 lb. of steam generated reduced to the same or equivalent conditions of evaporation.

Resetting Slipped Eccentric of D Slide-Valve Engine

How can a slipped eccentric be set on a D slide-valve engine without opening the steam chest? R. M.

Place the engine on a center and turn the eccentric around the shaft in the direction of forward rotation of the engine, alternately setting the eccentric and slightly opening the throttle valve to find the position of the eccentric for which steam is just admitted to the proper side of the piston, as shown by escape of steam from an indicator cock or cylinder pet-cock on the same side of the piston.

If the engine cannot be placed on a center, to reset the eccentric approximately, first turn the eccentric around the shaft in the running direction until, as shown by the indicator cock or cylinder pet-cock, the valve just admits steam on that end of the cylinder from which part of the stroke has been completed. Then estimate the angle that the crank is ahead of dead center and set the eccentric the same number of degrees forward of the position that just admits steam.

Quantity of Cooling Water

How can I estimate the amount of cooling water required for the condensing of our refrigerating plant? J. M. C.

The gallons of water required to be pumped over the condenser may be obtained by the formula

$$g = \frac{(H - q)W}{(t_1 - t_2)8.33},$$

where

g = Gallons of water per minute;
H = Total heat in one pound of ammonia entering condenser;
q = Heat of the liquid ammonia leaving condenser;
W = Pounds of ammonia circulated per minute;
t_1 = Temperature of entering water;
t_2 = Temperature of exit water.

The values of H, which consists of the latent heat of vaporization of the ammonia at the condenser pressure plus the superheat, may be obtained from a table of properties of ammonia. If the heat of superheat is not shown in the tables, this may be calculated by multiplying the difference between the actual ammonia temperature and the boiling temperature at the condenser pressure by 0.63.

Operation of Holly Steam Loop

In the Holly steam loop how is the condensation in the bottom of the receiver vaporized so it may be forced up into the receptacle placed on the roof of the building, whence it falls into the drop leg? T. J. R.

In operation of the Holly loop the condensation from pipes, traps and separators gravitates to the receiver, from which it is forced into the "riser" in the form of spray. The spraying effect is produced by forcing the condensate from the receiver through a series of small holes drilled in the sides of a short vertical pipe inside of the receiver that is connected to the bottom of the receiver like a standing overflow and that discharges through an outlet in the bottom of the receiver.

From this receiver the spray and moisture rise to the "discharge chamber," or receptacle placed on the roof of the building, on account of the lower pressure at that point, where the steam and entrained water are separated. The water thence falls by gravity to the drop leg, and the steam is discharged through a reducing valve into the feed-water heater.

Sweating and Corrosion of Economizer Tubes

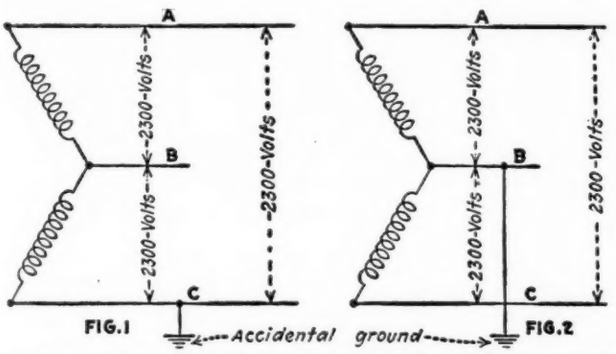
How can economizer tubes be prevented from sweating and corroding? A. F. S.

"Sweating," or deposits of condensation of moisture of the flue gases, can be prevented by supplying the economizer with water of not less than about 95 deg. F. Corrosion cannot be entirely prevented. It is more rapid when the tubes are not kept clean and from use of fuel containing much sulphur, especially when conditions are favorable to "sweating."

Voltage Tending To Cause Insulation Failure

In the figures are shown two conditions of grounds on a three-phase open-delta-connected 2,300-volt circuit. What voltage is the insulation subject to on the undergrounded conductors in each case? J. H. B.

Before the accidental ground occurred on the circuits, between any pair of conductors there were two thicknesses of insulation. Take the case of Fig. 1; when



FIGS. 1 AND 2. SHOWING LOCATION OF GROUND ON ONE LEG OF A THREE-PHASE CIRCUIT

both *A* and *C* were insulated from ground, before current could flow between these two conductors the insulation on both must fail or in other words the insulation on each conductor was subjected to one-half of 2,300 or 1,150 volts. After the insulation failed on *C*, there was only one thickness of insulation between *A* and *C*, therefore it was subjected to the total voltage on 2,300. This is also true of conductor *B*; 2,300 volts exists between *B* and *C*, and since the insulation has failed to ground on *C*, the insulation of *B* must stand the 2,300 volts, or if it fails there will be a short-circuit between *B* and *C*. This is also the case in Fig. 2; here the accidental ground is on conductor *B*, therefore the insulation on conductors *A* and *C* is subjected to 2,300 volts to ground.

Heating Surface of Tubes

In figuring the heating surface contained in the tubes of a return-tubular boiler, should the computation be based on the internal or the external surface of the tubes? J. H. A.

Boiler tubes are sized according to their external diameter and, for greater convenience, computations of heating surface usually are based on the external diameter of the tubes. But for return-tubular and other types of fire-tube boilers this method is inaccurate, because the true heating surface of a tube is the side exposed to the hot gases, and therefore calculations of boiler tube heating surface should be based on the inner surface of tubes in a fire-tube boiler and the outer surface in a water-tube boiler.

Change of Piston Clearance from Keying-up Connecting Rod

In keying up the brasses of an old style of engine connecting rod having each end fitted with strap, gib and key, how will the piston clearance be affected? A. R.

With that form of connecting-rod ends the effect of driving down the keys is to draw the brasses together and thereby shorten the distance between the centers of the crank and crosshead pins. As shortening the length of the connecting rod permits the piston, in a stroke toward the crank end, to come nearer the crank end of the cylinder, and prevents the piston in the opposite stroke from coming as near to the head end, keying up such a rod without compensating shims would cause the piston clearance to be increased in the head end and reduced in the crank end of the cylinder.

Resetting Loose Piston Rod

If the fastenings of the piston rod of an engine to the crosshead become loose or shifted, how would the trouble be indicated and how would the proper position of the rod be found? H. S.

Loosening of the piston rod in the crosshead would be revealed by a hammering noise at the beginning of each stroke, and sufficient withdrawal of the rod out of the crosshead would cause the piston to pound in the head end of the cylinder. The length of the connecting rod and connection of the piston rod with the crosshead should be such that there will be equal piston clearance in opposite ends of the cylinder.

For the purpose of making the adjustments, remove the cylinder head, place the engine on a center and make a mark on the crosshead that corresponds with a mark made on the guide; and turning the engine over to the other center, make another mark on the guide to correspond with the mark previously made on the crosshead. The distance between the marks on the guides will represent the length of stroke. Next disconnect the connecting rod, replace the cylinder head and move the crosshead to bring the piston hard against first one end and then the other end of the cylinder, and each time make a mark on the guide to correspond with the mark on the crosshead. The distance the crosshead has thus been placed beyond the marks previously made on the guide will be the piston clearance at corresponding ends of the stroke and should be the same for each end of the stroke. When the piston rod is screwed into the crosshead, considerable adjustment for equalization of the piston clearance for opposite ends of the stroke can be obtained by screwing the rod in or out of the crosshead, but the rod should be set with a length of the threaded end in the crosshead of not less than its diameter, plus two or three additional screw threads. In case equalization of the piston clearance by screwing the rod out of the crosshead could not be obtained without shorter length of the screwed end of the piston rod, or the rod is a taper fit in the crosshead, then equalization of the piston clearance must be made by proper shimming of the connecting rod.

American Boiler Manufacturers' Association Meets

The winter meeting of the American Boiler Manufacturers' Association was held at the Fort Pitt Hotel, Pittsburgh, on Monday Feb. 13, A. G. Pratt of the Babcock & Wilcox Co. presiding.

Walter Gordon Merritt, of the League for Industrial Rights, spoke in favor of the open shop and against militant unionism, and Ralph M. Easley, Chairman of the Executive Council of the National Civic Federation, against socialistic tendencies.

Secretary H. N. Covell reported that the Association comprised 77 active and 20 associate member companies and one honorary member, and that it has a comfortable balance in the bank.

George B. Bach, of the Union Iron Works, reported for the Committee on Ethics that even under the existing strenuous conditions of competition the attention of the committee had been directed to no breach of the Association's Code.

A. G. Pratt, reporting for the conference committee with the Stoker Manufacturers' Association, said that the proper setting height of hand-fired horizontal return-tubular boilers was under discussion, with prospects of a report at the spring meeting.

An attempt is being made to bring about agreement as to the height of stoker settings on the boiler front and as to who shall furnish the panel or other finish between the top of the stoker and the upper portion of the boiler front.

Mr. Bach called attention to the fact that some agreement as to covering the width of the front was also desirable, and F. G. Cox, of the Edge Moor Iron Co., observed that the stoker people often encroached so much upon the side walls as to interfere with the location of the buckstays.

Questionnaire on Code Observance

W. C. Connelly, of the D. Connelly Co., said that the committee appointed to determine to what extent the A.S.M.E. Code was being observed by the members of the Association, had sent out a questionnaire, the first inquiry of which was as follows:

1. Are you complying with the A.S.M.E. Code par. 14, 28, 36, 180 and interpretation No. 295? Of the 54 replies received 50 were "Yes," 1 "No," 3 "Not always."

2. Do you believe that a maximum thickness of shell plate should be fixed by the Code Committee?

Of the 54 replies 26 were "Yes," 10 "No," 18 did not build that type of boiler.

3. If so, what thickness of plate do you favor as a maximum? Seven answered $\frac{5}{8}$; 6 answered $\frac{7}{16}$; 3 answered $\frac{3}{4}$; 2 answered $\frac{7}{16}$; 4 answered $\frac{1}{2}$; 1 answered $1\frac{1}{4}$. Others were indefinite as that thickness depended upon size and other conditions.

4. If you do not believe in a maximum thickness, what are your reasons for opposing same?

Some did not think that experience had shown such limitations to be necessary; one replied that the girth seam may be protected over the fire; one that such details should be settled by the application of engineering principles; another that it depended upon local conditions. One thought that there should be no limit to progress and development.

5. Are you building all of your high-pressure boilers in accordance with the Code?

Answers: Forty "Yes," 10 "No," 4 "Partly."

"In building commercial boilers, that is, boilers that are not built to A.S.M.E., state or municipal standards or special specifications, are you then complying with the A.S.M.E. Code, par. 14, 28, 36 and 180, and interpretations of case No. 295, which states, "The minimum tensile strength under the A.S.M.E. Code must not exceed 55,000 lb. when figuring allowable working pressure"?

To this 31 replies were received—27 that 55,000 lb. was always used 4 that it was not.

One objected very strongly to the fixing of a maximum thickness, claiming that it was the result of propaganda by the builders of water-tube boilers.

One said that they had had no trouble with the fabrication of boiler plate since adopting the A.S.M.E. specifications, although trouble had been experienced before.

One manufacturer of externally fired multi-tube boilers cited boilers with thin sheets alongside of those with thick sheets, both burning oil. They had trouble with the thick sheets, but not with the thin ones, and he advocated thin sheets with 60,000 tensile strength. G. S. Barnum, of the Bigelow Co., explained that the trouble from thick plates came all in the seam. The Code requires the thickness at the seam to be reduced to $\frac{1}{2}$-in. He told of boilers built by the Bigelow Co. of $\frac{3}{4}$-in. plate planed down in this way, upon which especial care was exercised and which were found to be perfectly tight under 200 lb. Two years later they were leaking at every girth seam. He believed that so much reduction of thickness by displacement of the neutral axis resulted in a tendency to crimp which made it difficult to get and hold a tight joint.

E. C. Fisher, of the Wickes Boiler Co., gave $\frac{3}{4}$ as the limit. In the practice of his company they use $\frac{5}{8}$ on account of bad water, but districts where good water is obtainable ought not to be held down to that thickness. He is not satisfied that planing down at the joints is good practice. They had never had a lap-seam crack.

Using Single Sheet for Boiler Bottom

Replying to an inquiry as to whether the trouble could not be avoided by using a single sheet for the bottom of the boiler, Mr. Fisher said that with clean metal the conductivity was sufficient to convey away the heat, but with thick metal and the least bit of oil or scale there was likely to be trouble. A fusible plug would sometimes melt out until it was only about $\frac{5}{8}$ in. deep, then it would hold. The Association might go on record as considering the planing down of plates 1 or $1\frac{1}{2}$ in. thick as bad practice.

Mr. Brink, of the American Hoist and Derrick Co., thought it too bad that we have to limit the tensile strength of the material, and recommended that the A.S.M.E. Code committee be urged to institute some sort of research. It is a shame to use such thick plates where thinner plates with higher tensile strength would be better. He knew that a thick plate could be heated with a blow-torch without any water in contact with it and one side be at a red heat while the other is black.

Isaac Harter, of the Babcock & Wilcox Co., said that they had been dealing with 3-in. plate, but if one ordered it, the steel mills would tell him that he would have to take the whole heat of steel. They had been building some drums of $2\frac{1}{4}$-in. steel. Apart from the difficulty in handling material of that thickness he did not believe the tensile strength held up in proportion to the thickness. He told of tests on boiler tubes of different thicknesses. They put in thick and thin tubes alternately and ran the boiler under exaggerated conditions as to quality of water and rate of steaming. The light tubes were No. 10 and the heavy No. 6; in one case $\frac{1}{4}$-in. The heavy tubes outlasted the light ones almost in the ratio of 2 to 1.

F. C. Burton, of the Erie City Iron Works, said that 150 lb. is high enough for a horizontal return-tubular and $\frac{5}{8}$ is thick enough for that pressure.

Tensile Strength Advocated by Steel Manufacturers

M. F. Moore, of the Kewanee Boiler Co., said that when the matter was under discussion in the A.S.M.E. Boiler Code Committee, the best steel manufacturers did not want them to use a higher tensile strength than 55,000 lb. Charles L. Huston, of the Lunkens Steel Co., was largely responsible for the position which the Committee took in the matter.

John A. McKeown, of the John O'Brien Boiler Works, said that in answering the questions of the committee they had tried to base their answer on what was permissible by planing the plate to $\frac{1}{2}$ in. Since planing to $\frac{1}{2}$ they have had no trouble with firecracks but prior to that, there had been firecrack in seams.

Mr. Cox reported for the committee appointed to co-operate with the subcommittee on Inspection of the Code Committee, that the Code has practically been formulated, will be submitted for approval and contains no menace as to tolerances as had been apprehended.

In the afternoon "Limitations of the Field for the Use of Cast Iron Boilers" was discussed, and Mr. Dickson, of the Kewanee Boiler Co., objected to the propaganda that he said was being spread to the effect that steel boilers do not last. The heating contractor does not feel kindly toward the steel boiler, and plants are often laid out and so specified that one cannot get a steel boiler into them.

On motion of Mr. Fisher the paper and question were referred to a special committee.

C. W. Gorton presented a paper on the National Board of Boiler and Pressure Vessel Inspectors and its relation to the Boiler Manufacturing Industry. This Board is organized around the idea of One Code; One Stamp; One Inspection. It affords a means of having your boiler accepted in any one of a constantly growing number of states, if built to the A.S.M.E. Code, and provides for the acceptance of your shop inspector's certificate to the effect that it is so built providing the inspector has the indorsement of the National Board.

Mr. C. O. Myers, secretary-treasurer of the National Board, in reply to questions by Mr. Covell, said that Rhode Island, New Jersey, Wisconsin, Minnesota, Oklahoma, Oregon, California, Indiana and Utah have officially agreed to admit boilers bearing the stamp of the National Board.

Of the remaining Code States New York, Michigan, Delaware, Utah and Arkansas have not as yet officially declared their acceptance. A change is required in the law of Missouri to allow this to be done. There is a misunderstanding between the Board of Boiler Rules and the Inspection Department in Ohio. The Pennsylvania Industrial Board, while, it is said, intending to signify its acceptance of the Board stamp alone, passed a resolution declaring boilers bearing the Board Stamp *and* the Pennsylvania Stamp instead of *or* the Pennsylvania Stamp as admissible.

C. V. Kellogg, of the Kellogg McKay Co., addressed the association on the subject of "Taxation" and Mr. Fish on the "Code for Unfired Pressure Vessels." An invitation was received from the American Society of Mechanical Engineers for the Association to appoint a representative on the committee on Bolts, Nuts and Rivets.

Large Boilers Discussed at Stevens Institute by A. S. M. E.

On the evening of Wednesday, Feb. 15 the Metropolitan Section of the A. S. M. E. met with the Stevens Engineering Society at the Stevens Institute of Technology, Hoboken, N. J. The meeting was preceded by an inspection tour of the shops and laboratories of Stevens Institute.

The technical paper of the meeting was by V. Z. Caracristi, consulting engineer, New York City. This paper dealt broadly with the subject of large boilers and particularly with the installation at the River Rouge plant of the Ford Motor Co. A short abstract follows:

There is danger of using too great a furnace volume with a resultant increase in radiation and other losses. More coal should be burned per cubic foot of furnace volume. In this connection much could be learned from the steam locomotive. Of course the locomotive has a high stack temperature, but this could be greatly lowered in stationary plants.

The large boiler is not a freak development. It is justified on strictly economic grounds provided the load is sufficiently large and constant. Frequent starting or stopping seriously affect the brickwork. Blow-holes in the fire are bad for the same reason.

Differential expansion effects are worse with thick walls than with thin. With large furnaces it has been found that arches in the furnace walls reduce refractory troubles and make repairs easier. A careful study of coke-oven design would be of great help to the designers of boiler furnaces.

Stationary plants should try to approach locomotive practice, approximating 800 per cent of rating. That is, less heating surface should be used for the same service.

The River Rouge installation has now been operated long enough to give some idea of its success. Boiler No. 1 was started Nov. 12, 1920, and operated continuously for 140 days at loads ranging from 100 to 300 per cent of rating. After being shut down for inspection 6 days, it was run continuously for 133 days. The boiler was then shut down for cleaning the brickwork and repairing the superheater. Its last run started Sept. 20, 1921, and is still in progress.

Operation has been carried on without the deposit of ash on surrounding buildings. Ratings of 410 per cent have been reached, but 380 per cent is the highest rating ordinarily obtained in daily operation. No major repairs are expected for two or three years.

The combined burning of blast-furnace gas and powdered coal has been most successful. No A.S.M.E. test has yet been made, but this will be done as soon as the necessary testing equipment is secured. In testing one of these boilers it will be necessary to weigh a maximum of 350,000 lb. of water per hour.

The discussion was opened by H. Webster, of the Babcock & Wilcox Co., who stated that some of the most serious difficulties are those due to the attempt to burn low-grade fuels at a high rate of combustion per square foot of grate area. He said that the expression "Percentage of boiler rating" would some day pass out of use because it was illogical, particularly when comparing boilers a few tubes high with those many tubes high. According to Mr. Webster there is a demand for higher pressures at total temperatures around 700 deg. F.

George Orrok emphasized the importance of the human element. He also said that blast furnace designers had discovered the advantage of using thin furnace walls and that their experience might be useful to boiler men.

Kerckhoff License Granted

A license for the Kerckhoff development of the San Joaquin Light and Power Corporation, Fresno, California, was recently authorized by the Federal Power Commission. The development was made during 1919 and 1920 to take care of the rapid increase in load on the company's system, and was started under a temporary permit authorized by the Forest Service before approval of the Federal Water Power Act, which became a law while work on the project was in progress. Application for a license was transferred from the Forest Service to the Federal Power Commission, and the license authorized after a field investigation by the Commission's engineers.

The project consists of an arched dam 110 ft. high across a narrow gorge in the San Joaquin River, and a tunnel of 18 ft. square section, 3½ miles long, through a granite mountain. The tunnel joins the ends of a narrow horseshoe bend in the river, thus providing a head of 315 ft. on the turbines. It connects with three steel penstocks leading to the power house, where three water wheels, each of 15,000 hp. rating, are installed. The power is transmitted at 110,000 volts over 110 miles of line in the San Joaquin Valley. The project was described in *Power* Dec. 14, 1920.

Italy Short of Power

The industrial zone in northern Italy is threatened with an unprecedented power shortage, which will reach its peak April 1, according to the Department of Commerce. An abnormally small snow-fall in the northern mountains last winter, together with the intense cold that lasted throughout the Summer in the upper mountain levels, hindering melting, have caused the streams that are relied on for power to fall to very low levels.

In an effort to develop new sources of water power, it has been proposed to tap a number of lakes, in one case making interconnection between two lakes by means of syphons over intervening hills.

The power shortage has become so serious that curtailments already have been made of the less essential uses, and it may become necessary to supplant electric traction with steam locomotives on the Milan-Varese railway. Restriction of the use of electric lights in homes to two hours daily is under consideration. One industrial plant has rigged up a battery of farm tractors to furnish power for some of its generators.

What Trade Associations May and May Not Do

Recent cases in which trade associations have got themselves into trouble with the Department of Justice through violation of the anti-trust act have brought about a great deal of confusion as to just what these organizations may and may not do in helping their members, while still remaining within the law. In order to straighten out the situation, Secretary Hoover of the Department of Commerce has been in correspondence with Attorney General Daugherty, and their letters, recently made public, give authoritative information for the guidance of such associations. The main points agreed upon are given here. There was practically no important disagreement between the Secretary and the Attorney General.

Secretary Hoover pointed out that he had looked into the activities of trade associations with the idea of securing their help in obtaining trade information for the government, and that in that investigation he found that some of them were not keeping strictly within the law. He strongly emphasized his position that no objection should be made to trade associations as such, nor as to their means of securing their information, but that objection is made solely toward their use of this information. He said also that the great majority of trade associations are legitimate, both in form of organization and in activity. The minority, he explained, although organized on a lawful basis with proper purposes, actually carry on activities contrary to such purposes; and in other cases, even though the association and its officers may do nothing unlawful, the members themselves use the information lawfully secured for unlawful purposes.

The Secretary left no doubt as to his belief in the trade association idea by saying, "It is with much earnestness that I claim there is propriety, generally speaking, in trade associations. Their lawful field of endeavor is large, and their activities work for promotion and advancement of the public welfare for progressive economic organization."

On the other hand, he took a position that will probably not be regarded so favorably by trade associations, when he insisted that they have no right to secure and compile statistics about their trade unless they make this information available to the public generally at the same time at which they give it to their members, saying "It is my belief that good morals and a sense of fair dealing require the giving of the information secured in this collective manner to the public generally, to the end that all persons engaged in commercial transactions involving the information in question will be on an even footing."

In order to make the government's position as clear as possible, Secretary Hoover put a series of questions to the Attorney General, inquiring as to just what trade associations may do without violating the law. The answers to these questions, as modified by the correspondence that followed, are summarized in the following paragraphs.

A trade association may provide a uniform system of cost accounting for its members, but the Attorney General insisted that they should be warned against fixing a uniform cost as to any item of expense.

A trade association may work for uniformity in the use of trade phrases and names by its members in order to end confusion as to the meaning of such terms.

It may provide for standardization of quality of the product of its members and may also provide a standard form of contract, may standardize technical and scientific terms, production processes and machinery, and may cooperate with its members in eliminating waste in production and distribution.

It may collect credit information about those using the products of its industry and may furnish such information to its members, provided "black lists" are not established.

It may arrange for or place all the insurance of the members.

It may engage in co-operative advertising for the promotion of the trade as a whole.

It may promote welfare work, such as sick benefits, unemployment insurance, etc.

It may handle for its members all legislative questions affecting the industry, such as employers' liability and workmen's compensation, rate litigation and railroad transportation.

It may promote closer relations between the industry and the government.

It may collect from its members statistics on volume of production, wages paid, stock on hand, etc., may compile this information into a consolidated statement, which may be classified by geographical districts, and may file the combined statement with the Secretary of Commerce for distribution by him to the members of the association through the public press or otherwise, to the public generally and to all persons who may be in any way interested in the product of the industry.

It may, at the same time, collect statistics on prices received by members for their products, may consolidate these figures into a report showing the average price received for the total volume of each grade, brand, size, style or quality, as the case may be, classified by districts, and may send the report to the Secretary of Commerce, as in the previous paragraph.

Coal Freight Rates Should Be Cut, Says Hoover

In the course of a recent statement on the railroad situation, made in connection with the freight-rate investigation of the Interstate Commerce Commission, Secretary Hoover declared himself emphatically in favor of lower freight rates upon coal and some other products, saying:

If I were to discuss the rates charged today, I should say at once that a decrease in passenger rates is not nearly so vital to the community as freight rates, for passenger rates do not enter into the "spread" in proportion to the relative volume of earnings. If I were examining the freight rates, I should at once say that coal, metals, wood and agricultural and other producers' goods should be reduced to the bottom before L C L and class rates are touched.

In general Mr. Hoover's opinion was that the railroad situation is the most important factor to be considered in re-establishing industry and getting back to normalcy. He was confident that the present industrial depression will not long continue, and pointed out that when industries have resumed operations on a normal scale, the country's business will be strangled by the inability of the railroads to handle the goods that will be offered them, unless something is done now to re-establish the full capacity and efficiency of our transportation system. On this point he said:

If we look at the national economic situation as a whole, the greatest impulse that can be given to recovery from any source whatever is a reduction of rates on primary commodities combined with the immediate resumption of railway construction and equipment. The first depends upon reduction of operating costs, the second upon restoration of credit for our railways.

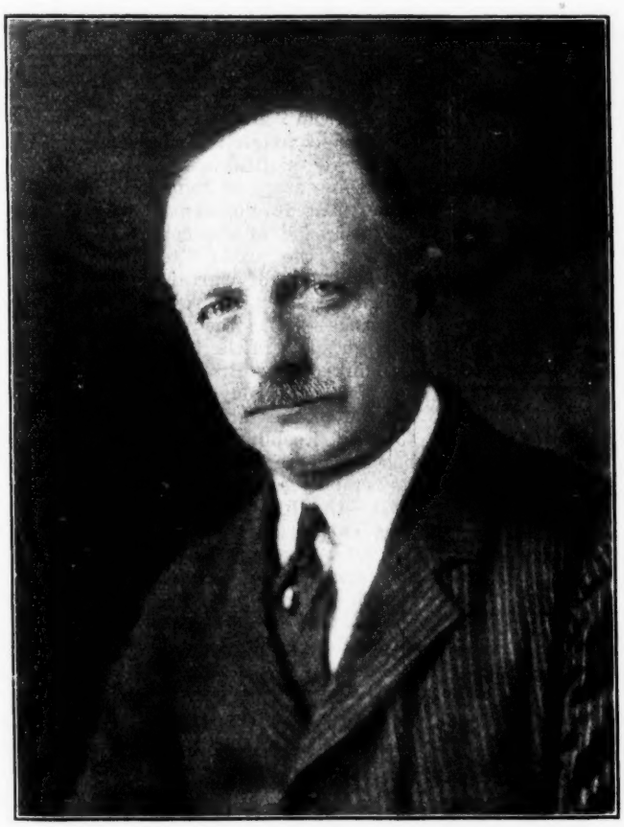
Calling attention to the general attitude of investors that the railways will never again earn profits, Mr. Hoover gave it as his opinion that not only is this wrong, but that the railways will become very profitable. However, he pointed out that the necessary equipment for the railroads is lacking, that confidence is at a low ebb, and that "we are driving headlong for a setback to our whole commerce the very moment that we begin to get on our feet." The Secretary's confidence in the future of the railroads was such that he proposed that, if necessary, the Government should guarantee to equipment trusts payment by the railroads for needed equipment, saying:

In these circumstances it seems to me vital that the railways as our greatest industry should propose a courageous program of broad-visioned betterments and if necessary the Government should consider giving the use of its superior credit. It would not cost the taxpayer a cent to give the

Government's guarantee to equipment trusts upon the primary responsibility of the railways, the proceeds to be devoted entirely to improvement and equipment. This is no proposal to take money from the taxpayer. It is a proposal to save him from paying treble the amount of his guarantee in profiteering and losses. It will render a reduction of rates earlier, for unless something is done the improvements will have to be paid over years out of increased rates. Nor would we lose a cent upon the guarantee, for if American railways cannot earn interest upon their borrowings let us throw up our hands and prepare for a second Russia.

Death of Richard Rice, Designer of Steam Engines and Turbines

Richard H. Rice, who will be remembered for the slow- and medium-speed steam engines designed by him with John W. Sargent, and manufactured by the Rice & Sargent Co., and who has been better known in recent years for his work with the General Electric Co. as turbine designer and as manager of the Lynn (Mass.) works, died



RICHARD H. RICE, WHO DIED FEB. 10 AT THE AGE OF 59 YEARS

suddenly of heart failure on Feb. 10. He was snowshoeing near a camp at Bolton, on Lake George, N. Y. He had gone there in an effort to recover from the shock caused by the death of his son, who had died only eight days before.

Mr. Rice was known among his friends for his more than ordinary charm of personality, his readiness to cooperate in public-spirited enterprises, and his way of getting along harmoniously with his associates and assistants. Among engineering and technical men, he was highly regarded for his invention of some fifty patented devices involving the use of steam, air or water, for his part in the designing of the Rice & Sargent engine, and for his development of the steam turbine during his connection with the General Electric Co. In the first years of his work at Lynn he was responsible for the designing of the smaller types of Curtis turbines up to 5,000 hp., his ability in this line of work resulting in 1918 in his appointment as manager of the Lynn plant.

Mr. Rice was born Jan. 9, 1863, in Rockland, Me., where he received his preliminary education. In 1885 he was graduated from Stevens Institute as a mechanical engineer, and last June was awarded by the Institute the degree of Doctor of Engineering. After graduation he worked as construction engineer with the Pennsylvania R.R.; as a draftsman with the Bath Iron Works and with E. D. Leavitt, Jr., a consulting engineer; and later as general superintendent of the William A. Harris Steam Engine Co., of Providence, R. I., where he had charge of the design of ship-propulsion machinery. His next position was as secretary-treasurer of the Rice & Sargent Engine Co., of Providence, and from that work he went directly to Lynn in 1903, his connection with the company being that of consulting steam engineer. In 1918 he succeeded Walter C. Fish as manager of the plant.

In public work Mr. Rice was most active and was prominent in movements for the betterment of industrial relations. During the war he served on the State Fuel Conservation Committee. He was a member of a number of clubs and manufacturers' associations, and was also a member of the American Society of Mechanical Engineers and the Providence Association of Mechanical Engineers. He left a wife and two daughters.

Coal Chute as Exit for Employees

BY A. L. H. STREET

The mere fact that a coal-chute door may have been used occasionally by employees as a passageway in going to and from their work, to the employer's knowledge, did not convert it into such way as to require the employer to keep it in reasonably safe condition for that purpose, holds the Kentucky Court of Appeals in the case of Staley vs. Wehmeier, 219 "Southwestern Reporter," 408. In this case the plaintiff was denied the right to recover damages for injuries sustained through stumbling over a board in the doorway. The court said:

> Its use exclusively for fuel was inconsistent with the theory that it was intended as a passageway or that its use was such as to impose upon the master the duty to keep it reasonably clear or safe for that purpose. To reach this door, it was necessary to walk under beltings and around and near machinery, thus further indicating it was not intended as or for a passageway. The master is required to maintain reasonably safe structures for servants while in the performance of his work and reasonably safe approaches to enable them to go to and depart from their place of work. The master in the present case had provided other safe ways of entering and leaving his plant, and it was never intended the coal door should be used for this purpose.

A hydro-electric plant that will produce about 16,000,000 kw.-hr. per year is nearing completion at Piana dei Greci, near Palermo, Italy, according to the Department of Commerce. The dam is 110 ft. high and 980 ft. long, providing nearly 20,000,000 cu.yd. of storage. The water has a drop of 1,550 ft., driving three groups of turbines and alternators of 3,500 kw. each. The project also permits of some use of water for irrigation in the Palermo Valley.

Bituminous-coal production is increasing steadily. In the week ended Jan. 28 it was 9,626,000 net tons, which was 9.5 per cent more than the preceding week. It was also considerably above the average of about 7,800,000 tons for 1921. The principal reason for the increase is probably the approaching strike, although another cause may be found in increasing industrial activity.

"Needs must when the devil drives," and so when the recent terrific storm that swept the Atlantic Coast held back the Ward Line passenger steamer Morro Castle until its coal supply was almost exhausted, steam was kept up by burning 300 bags of sugar, the last 50 tons of coal being saved to bring the vessel into port when the storm went down.

News in the Field of Power

Patent Office Bill Passed by the Senate

The Patent Office Relief Bill was passed by the Senate Feb. 14 without the necessity of a roll call, and will become a law as soon as the President signs it, having already been passed by the House by a vote of 305 to 44. As no mention has been made of any intention on the part of the President to refuse his signature, it may safely be said that the long fight to put the Patent Office on a business basis has come at last to a successful end.

Conditions in the Patent Office had reached an almost hopeless stage, for salaries had been increased only 10 per cent since 1848, with the result that the office has been unable to retain competent men and has practically been turned into a training school for ambitious patent attorneys. The work has piled up faster than it could be handled, and it was impossible to give every application the attention and study that it ought to have had to prevent future disagreement and litigation.

To eliminate this unfortunate condition the bill provides: a substantial increase in salaries, particularly to the technical employees of the office; an increase in personnel; and authority to raise patent fees sufficiently to cover the increased expenditures.

As has been mentioned previously in *Power*, it is only right that some credit should be given to the engineering and technical organizations that have so actively supported this legislation, and whose efforts must surely have had some effect in finally bringing about its adoption. In this connection it seems in order to point out that the technical press has done its part in securing this result by throwing the discomforting light of publicity upon the inexcusable failure of Congress to meet the reasonable needs of the Patent Office.

Wide Interest in Superpower

Dr. George Otis Smith, the director of the United States Geological Survey, under whose direction the Superpower Report was prepared, believes that the showing of economies presented in the report has stimulated interconnection between existing systems throughout the country. The nation-wide interest that has been taken in the survey is indicated by the fact that the entire edition of 10,000 copies of the report has been exhausted. In addition, literally thousands of inquiries have been received in regard to various phases of the problems involved. Other evidences of the interest aroused, Dr. Smith points out, are given in the space accorded the project in the technical press and the large amount of discussion that it has caused in technical societies.

Commerce Secretary Hoover states that the Superpower Report has stimulated the desire for similar studies in the Pittsburgh-Chicago area and in other sections.

Coal Miners Willing To Keep Present Wage Scale

A favorable turn in the coal-strike situation came at the convention of the United Mine Workers of America at Indianapolis, Feb. 14, when the Wage Scale Committee recommended that no wage increases be asked, but that the miners "insist that the present wage schedule be maintained" in the bituminous coal field. A strike was recommended, however, if it proves impossible to secure an agreement on these lines.

It is coming to be expected by the mine workers that the Government will intervene if a strike appears to be unavoidable. No such announcement has been made by the Department of Labor or the Department of Commerce, but the former has had two commissioners of conciliation at the convention to observe and report upon it to the Government officials.

The Upward Turn

We all know that business is looking up, and that when industry gets back to normal production it will need more power and more men who understand power. But a more definite fact that applies more particularly may be seen in the recent announcement of one of the manufacturers of large power apparatus, reporting a marked increase in sales. In January its sales of turbo-generators and condensers reached $1,500,000, and 50 steam auxiliaries were sold, many of them to industrial plants.

The signs are definite, they are unmistakable, and they point to the upward turn that means more power plants, more demands upon existing plants and more opportunities for men who know how to turn out power with the minimum of waste.

Engineers' Club for Atlanta

The Atlanta Section of the American Institute of Electrical Engineers has gone on record as favoring the formation of an engineers' club for Atlanta, and has appointed a committee, which has made an investigation, chosen a tentative site and is now working to complete arrangements for the club. The proposed clubhouse is to contain an assembly hall, where the monthly meetings of the various societies can be held, lounging rooms, reading rooms, a library, restaurant facilities, etc. Membership will be open not only to members of national societies, but to all those engaged in engineering work.

New Publications

Outspinning the Spider. By John Kimberly Mumford. Published by the Robert L. Stillson Co., for the John A. Roebling Sons Co., Trenton, N. J. Paper, 6 x 8½ in., 137 pages. Distributed on request.

In these days of aggressive and often strident salesmanship it is a relief to read a book like this. True, it is largely about the Roebling company, and highly in praise of it; yet it is far from being a vainglorious recitation of commercial achievement. Instead, its skillful author has told an absorbing story of John Roebling's discovery and development of wire-making methods and of the countless applications of the product to the needs of industry and of warfare. He has not fallen far short of proving his opening sentence—"It is the wire age."

High spots in the book deal with the building of the Brooklyn Bridge, with the part wire played against the submarine in the late war, and with the town of Roebling, which the company has founded on the Delaware River for its employees. But throughout the work—the life-story of a great business enterprise that has been handed down from generation to generation—the romance of engineering and a wealth of human interest have been woven with a cleverness that makes interesting reading.

Personals

L. B. Fessenden, chief engineer of the Sheboygan power plant of the Eastern Wisconsin Electric Co., has become president of the Fessenden Ellis Co., which has recently been incorporated to manufacture pressure governors in Sheboygan.

William F. Parish, president of the American Society of Lubrication Engineers and member of a number of other societies, has opened a petroleum analytical and experimental laboratory, and will carry on a practice as a consulting lubrication engineer with offices in the Peoples' Gas Building, Chicago.

Charles R. Richards, dean of the College of Engineering of the University of Illinois and active in committee work in the A. S. M. E., has been elected president of Lehigh University, South Bethlehem, Penn. Dean Richards is chairman of the Fuels Committee of

the A. S. M. E. Committee on Power Test Codes and was intimately connected with fuel conservation work during the war. He received the degree of B.M.E. in 1890 and M.E. in 1891, at Purdue University, and of M.M.E. in 1895 at Cornell.

Society Affairs

Coming Conventions

American Society of Mechanical Engineers — Spring meeting at Atlanta, Ga., May 8-11. Secy., Calvin W. Rice, 29 West 39th St., New York City.

National Electric Light Association —Annual convention at Atlantic City, N. J., May 15-20. Headquarters, 29 West 39th St., New York City.

The Association of Iron and Steel Electrical Engineers has selected the New Auditorium at Cleveland, Ohio, for the 1922 national convention and exhibition, Sept. 11-15. Booths are now being released at the headquarters of the Association in the Empire Building, Pittsburgh, Pa.

Lynn Section, A. I. E. E., will meet March 1 to hear S. W. Stratton, director of Bureau of Standards, tell of the bureau's work.

Schenectady Sections of the A. I. E. E., the A. S. M. E. and the American Society of Heating and Ventilating Engineers, and other organizations, will hold a joint meeting March 3 at which the activities of the A. S. H. & V. E. Experiment Station at Pittsburgh will be described by F. Paul Anderson, the director of the station.

Buffalo Section, A. S. M. E., is to hear a lecture March 1 on "Principles of Design of Hydraulic Turbines and the Details of Their Construction," by W. M. White, of the Allis-Chalmers Co., who invented the hydraucone regainer.

Metropolitan Section, A. S. M. E., will hold a joint meeting with the A. I. E. E., Feb. 24 to hear the following papers on Central Power Station Operation: "Report on Tests of the 66,000-kw. Westinghouse Turbine of the Interborough Rapid Transit Company," By H. B. Reynolds and W. F. Hovey, both of the I. R. T. Co.; "Present-Day Boiler-Room Operation," by I. E. Moultrop, assistant superintendent of construction of the Edison Illuminating Co. of Boston; "Electric Drive for Steam Generating-Station Auxiliaries," by H. C. Albrecht, engineer of the Philadelphia Electric Co.; "Three-Phase, Four-Wire Distribution System," by Thomas Sproule, of the Public Service Electric Co.

Business Items

The Hauck Manufacturing Co., manufacturer of portable oil burners, furnaces, etc., has moved its Philadelphia office to 1726 Sansom Street.

The Homestead Sales Corporation, 242 Lafayette St., New York City, has been appointed sole agent for New York and vicinity by the General Specialty Co., of Buffalo, N. Y., for the sale of its torpedo-tube cleaner and other boiler-cleaner specialties.

Cote Bros. Manufacturing Corporation, First National Bank Building, Chicago, has established branch offices in New York, Philadelphia, Boston, San Francisco, Cleveland, Tampa, and Denver.

The Files Engineering Co. has announced that its hand stoker is now manufactured and sold by the Gibby Engineering Co., East Boston, Mass. The whole executive, engineering and sales organization of the Files company's stoker division has been taken over.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine-run bases, f.o.b. mines.):

Coal	Market Quoting	Feb. 6, 1922	Feb. 13, 1922
Pool 1,	New York	$2.85	$2.75@3.25
Pocahontas	Columbus	2.15	1.75@2.10
Clearfield	Boston	1.95	1.70@2.25
Somerset	Boston	1.90	1.75@2.00
Pittsburgh	Pittsburgh	2.15	2.10@2.20
Kanawha	Columbus	1.65	1.50@1.80
Hocking	Columbus	1.75	1.75@2.00
Pittsburgh No. 8	Cleveland	2.00	1.95@2.00
Franklin, Ill.	Chicago	2.35	2.25@2.75
Central, Ill.	Chicago	2.35	2.25@2.50
Ind. 4th Vein	Chicago	2.50	2.35@2.65
Standard	St. Louis	1.90	1.85@2.00
West Ky.	Louisville	1.90	1.70@2.00
Big Seam	Birmingham	1.85	1.75@2.00
S. E. Ky.	Louisville	1.45	1.50@1.75

New York—On Feb. 15, Port Arthur light oil 22@25 deg. Baumé 4c. per gal. 30@35 deg., 5c. per gal., f.o.b. Bayonne, N. J.

Chicago—Feb. 9, for 24@28 deg. Baumé, 85@90c. per bbl.; 32@36 deg., 2⅜@2½c. per gal. in tank cars f.o.b. Oklahoma refinery, or freight adjusted.

Pittsburgh—On Feb. 14, f.o.b. refinery, Pennsylvania, 38@40 deg. 4¼c. Kentucky fuel oil, 26@30 deg., 3c. per gal.

St. Louis—Feb. 11, prices f.o.b. cars, tank lots; 24@26 deg. Baumé, 75c. per bbl.; 26@28 deg., 85c.; 28@30 deg., 95c.; 32@34 deg., 2½c. per gal.

Philadelphia—On Feb. 13, 26@28 deg. Baumé, Oklahoma, 75@80c. per bbl.; 30@34 deg., Oklahoma (group 3) 2¼@2⅜c. per gal.; 16@20 deg., Seaboard, $1.15@$1.25 per bbl.

Cincinnati—Feb. 13, for 26@30 deg. Baumé, 4c.; Diesel 32@34 deg., 4½c. per gal.; distillate 38@46 deg., 5¼c. per gal.

Cleveland — Feb. 13, 26@30 deg. Baumé, 3c. per gal.

New Plant Construction

PROPOSED WORK

Cal., Fresno—J. P. Ryland and O. L. Everts, 1906 North Van Ness St., are having plans prepared for a 5 story, 100 x 150 ft. apartment on Stanislaus and N Sts. About $350,000. Glass & Butner, Cory Bldg., Archts.

Cal., Oakland—The Pacific Gas & Electric Co., 445 Sutter St., San Francisco, plans to construct a water tank of 10,311,770 gal. capacity and new compressors, transmission equipment, etc. Cost about $1,000,000.

Cal., Orange Cove—The Foothill Irrigation Dist., L. J. Wilams, Secy., plans irrigation of 55,364 acres involving the construction of 55 miles of lined canals and pumping plants, 3 centrifugal 24 in. 100 cu.ft. sec. with lift of 100 ft. and 2,600 h.p. motors.

Cal., San Francisco—Beckman & Linden Engr. Corp., 604 Mission St., San Francisco, preparing plans for irrigation project in Amador and Calaveras counties, utilizing water from the Calaveras and Mokelumne rivers involving the construction of 5 miles of tunnels and canals, a concrete division dam, 32 ft. high, ditch, 32,000 ft. long; Cyclopean masonry dam, 185 ft. high, 1,400 ft. long on top and 200 ft. on bottom; power house equipped with Pelton water wheels, pumping plants, etc. Total cost about $1,000,000.

Conn., Hartford—C. J. Malmfeldt, Archt., 206 Trumbull St., will receive bids about March 1 for a 7 story, 50 x 160 ft. maternity ward building at hospital on Hudson St. for the Hartford Hospital, 20 Hudson St. About $500,000.

Conn., Windsor—A. Helebrand is in the market for a 25 hp. horizontal steam engine.

Ill., Aurora—The Chicago, Burlington & Quincy R.R., 547 West Jackson Blvd., Chicago, is having plans prepared for a power plant. About $100,000. W. T. Krausch, 547 West Jackson Blvd., Chicago, Engr.

Ill., Beardstown—The Gorman Ice & Coal Co., plans to build a 1 story, 30 x 42 ft. addition to its ice plant. About $25,000. Architect not selected.

Ill., Chicago—S. Clifford & Co., 10 South La Salle St., is receiving bids for a 3 story, 120 x 133 ft. apartment including a steam heating system on Juneway Terrace, near Lake Michigan. About $400,000. D. W. Turbyfil, 3760 Sheffield Ave., Archt.

Ill., Chicago—The Harrison Clark Bldg. Corp., c/o Davidson & Weiss, Archts., 53 West Jackson Blvd., is having plans prepared and will soon receive bids for a 10 story, 100 x 100 ft. office building including a steam heating system on Harrison and Clark Sts. About $500,000.

Ill., Chicago—R. L. Langford, 1533 East 53rd St., is having plans prepared for a 5 story, 129 x 180 ft. hotel including a steam heating system on Marquette Rd. and Stony Island Ave. About $400,000. S. S. Beman and T. R. Bishop, 35 South Dearborn St., Archts.

Ill., St. Charles—The Anderson Dairy Co. is in the market for an 8 to 12 hp. high pressure boiler.

Ind., Ft. Wayne—The Keenan Hotel Co., c/o Anthony Hotel, 128 West Berry St., is receiving bids for a 15 story, 90 x 110 ft. hotel on Harrison and Washington Sts. About $900,000. C. R. Weatherhogg, Citizens Trust Bldg., Archt. Noted Jan. 10.

Ind., Indianapolis—R. F. Daggett, Archt., Lemcke Annex, will receive bids until March 1 for an 11 story, 100 x 200 x 127 ft. athletic club including a steam heating system on Vermont and Meridian Sts. for the Indianapolis Athletic Club, H. K. Campbell, Pres., c/o H. C. S. Motor Car Co.

Ind., Indianapolis—The Medical & Dental Realty Co., 822 Hume Munsur Bldg., plans to build a 15 story office building. About $1,000,000. D. Graham, 1128 Hume Munsur Bldg., Archt.

Ind., Indianapolis—The Northern Realty Co., c/o George & MacLucas, Archts., 1153 Lemcke Annex, is having plans prepared for

a 3 story, 60 x 170 ft. apartment (2 units) including a steam heating system on North Pennsylvania St. About $350,000.

Ind., Rockville—The Bd. of Trustees, Ind. State Sanitarium, A. Carter, Supt., will receive bids until March 9 for two 2 story, 45 x 100 ft. and one 60 x 110 ft. sanitarium including a steam heating system, refrigerating plant, insulating cold storage rooms, etc. About $150,000. Shourds-Stoner Co., 511 Tribune Bldg., Terre Haute, Archts.

Kan., Salina—The Natl. Bank of America, is having plans prepared for a 7 story, 58 x 100 ft. bank and office bldg., including a steam heating system. About $400,000. Wight & Wight, First Natl. Bank Bldg., Kansas City, Mo., Archts.

Kan., Wichita—The Bd. Educ. voted bond of $1,000,000 for a high school, including a steam heating system. Lorentz, Schmidt & Co., 121 North Market St., Archts. Noted July 12.

Ky., Newport — The City Waterworks Comn. will receive bids within 90 days for a 6,000,000 gal. pumping engine for the Newport waterworks.

La., New Orleans—The Federal Reserve Bank, Camp St., will soon award the contract for a bank and office building on Carondelet St. About $1,500,000. R. DeBuys, Camp St. and Commercial Alley, Archt. and Engr.

Mass., Winchester—The town plans to build a junior high school on Main St. About $350,000. R. C. Sturgis, 120 Boylston St., Boston, Archt.

Md., Baltimore—W. H. Emory, Jr., Archt., Munsey Bldg., is preparing plans for a hotel including a steam heating system on Guilford and Lexington Sts. About $400,000. Owner's name withheld.

Md., College Park—The University of Maryland plans to build a 2 and 3 story college building. About $400,000. Flourney & Flourney, 306 St. Paul St., Archts.

Mich., Grand Rapids—B. K. Gibson, Archt., 608 South Dearborn St., Chicago, Ill., is receiving bids for an 8 story, 152 x 154 ft. hotel (Howe) including a steam heating system on Monroe and Michigan Sts. for the Furniture City Realty Co., 515 Lyons Ave. About $1,000,000. Noted Nov. 29.

Minn., Red Wing—The city council passed ordinance to erect and equip municipal electric light and power plant. About $350,000.

Minn., St. Paul—The Daily News Publishing Co., 94 East 41st St., is having plans prepared for a 6 story, 75 x 135 ft. newspaper plant and office building, on 4th St., between Cedar and Minnesota Sts. About $225,000. Toltz, King & Day, 1410 Pioneer Bldg., Archts.

Minn., Waseca—The Bd. Educ., C. H. Bailer, Clk., plans to build a 3 story high school including a steam heating system. About $250,000. W. B. Ittner, Bd. Educ. Bldg., St. Louis, Mo., Archt.

Mo., Lina Creek—W. R. Banks Lamar, plans to build 3 dams and power houses on Osage River, dams will vary from 15 to 40 ft. in height, combined capacity about 3,000 hp. About $30,000. Engineer not selected.

Neb., Omaha—The Bd. Educ., W. T. Bourke, City Hall, plans to build a 3 story high school on 31st and Ames Sts. to be known as the North High School. About $750,000. J. Latenser & Sons, 732 Peter Trust Bldg., Archts.

N. J. East Orange—D. M. Ach, Archt., has prepared plans for a 7 story apartment on Harrison St. About $500,000. Owner's name withheld.

N. Y., Long Beach—The Alexandria Hotel Co., c/o Severances & Van Alen, Archts., 372 Lexington Ave., New York City, is having sketches made for a hotel on Boardwalk. About $1,000,000.

N. Y., New Brighton—The Bd. Educ., C. B. J. Snyder, Supt., Municipal Bldg., New York City, will receive bids until Feb. 27 for installing heating and ventilating apparatus in additions to Curtis High School on Hamilton Ave. and St. Marks Pl.

N. Y., New Rochelle—The Trinity Arms Corp., c/o P. J. Rocker, Archt., 6 East 46th St., will soon receive bids for an 8 story apartment on Huguemot St. About $750,000.

N. Y., New York—The Bd. Educ. plans to build a 237 x 285 ft. school on East 179th St., between Mehegan and Honeywell Aves. Architect not selected.

N. Y., New York—The Citizens Savings Bank, 58 Bowery, is having plans prepared for a bank. About $400,000. C. W. Brazer, 1133 Bway., Archt. and Engr.

N. C., Durham—The city is receiving bids for the installation of refrigerating plant at city market. About $15,000.

N. C., Raleigh—The State Hospital plans the installation of new steam engine driven electric generating unit, switchboard, remodeling and enlarging ice making and refrigerating equipment, new ice storage room, etc. About $25,000. H. A. Underwood, 227 Forest Rd., Engr.

O., Cincinnati—P. S. Hannaford & Sons, Dixie Terminal Bldg. and Garber & Woodward, Union Central Bldg., Archts., will receive bids until March 1 for an 11 story, 88 x 200 ft. clubhouse including a steam heating system on 8th and Race Sts. About $2,000,000.

O., Cleveland—The Bd. Educ., East 6th St. and Rockwell Ave., H. E. Boppel, purch. agt., is in the market for equipment as follows: Twelve voltmeters; 9 ammeters; 2 milliameters; 3 wattmeters; 25 rheostats; 10 motors; 3 transformers; 1 alternator 3 generators; 1 compensator; 8 circuit breakers and 1 tachometer.

O., Cleveland—The Ward Baking Co., c/o J. B. Arthur, East 143rd St. and Southern Blvd., New York City, is having plans prepared for a 4 story baking plant on East 45th Pl. and Perkins Ave. About $300,000. C. B. Comstock, 110 West 40th St., New York City, Archt.

O., Columbus—The Bd. Educ., E. L. McCune, Clk., Town and High Sts. plans to build a 2 story elementary school (Fairwood Park School) on East Livingston Ave. About $300,000. H. D. Smith, 50 East Town St., Archt.

O., Columbus—The Bd. Educ. Town and High Sts., will receive bids about March 1 for a 2 story, 200 x 375 ft. high school on East Broad St. About $1,000,000. W. B. Ittner, Bd. Educ. Bldg., St. Louis, Mo., Archts.

O., Columbus—The City Ice Supply & Coal Co., E. Prior, Pres. and Genl Mgr., 38 Mithoff St., is having plans prepared for a 60 x 200 ft. ice plant on 22nd St. About $35,000. Will be in the market for a complete electrically operated ice manufacturing plant. Cost about $65,000. Private plans.

Pa., Clearfield—The Clearfield Machine Shops, 4th St., is in the market for a single stage air compressor, capacity about 90 cu. ft. per min. at 80 lb. air pressure, belted from motor.

Pa., Monessen—J. M. Beall & Sons, Archts. will receive bids until Feb. 24 for a 2 story, 138 x 200 ft. high school for the Bd. Educ. About $300,000. Noted Mar. 9.

Pa., Pottstown—W. F. Focht, 157 High St.—one 2 ton ice manufacturing machine.

Va., Danville—The city plans to install electric pump in pumping plant capacity 5,000,000 gal. per 12 hr.

Va., Hampton Roads — The Bureau of Yards and Docks, Navy Dept., Wash., D. C., will receive bids until March 15 for a motor generator set and switchboard for the Naval Base Hospital here. Noted Jan. 10, Spec. 4570.

Va., Norfolk—The city is in the market for boilers, pumps, engines, etc., for alterations to City Hall Ave. and Myers Ave. pumping stations. About $10,000. D. A. Decker, Armory Bldg., Engr.

Va., Richmond—Miller & Rhodes Co., Inc., 6th St., will soon receive bids for a 5 story, 156 x 195 ft. addition to department store on 6th and Grace Sts. About $1,000,000. Starrett & Van Vleck, 8 West 40th St., New York City, Archts. and Engrs.

Wash., Tatoosh—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., will receive bids until March 22 for operating and power building, and water and sewer system. Noted Jan. 10 Spec. 4574.

W. Va., Charleston—H. A. Robson, Charleston Natl. Bank Bldg., and H. G. Smith, are having plans prepared for a market to be known as Charleston Sanitary Market on Dickinson St. About $175,000. D. Dick & Son, 8 Masonic Bldg., Archts. Equipment including refrigeration system will be installed, cost about $100,000.

Wis., Elkhorn—The Wisconsin Butter & Cheese Co. plans new electric generating unit. Cahill & Douglas, 217 West Water St., Milwaukee, Engrs.

Wis., Fond-du-Lac—The Commercial Natl. Bank, F. A. Boyd, Cashier, 938 Main St., is having plans prepared for a 6 or 7 story, 60 x 110 ft. bank and office building including a steam heating system on 1st and Main Sts. About $650,000. S. Lovell, 30 North Michigan Ave., Chicago, Ill., Archt.

Wis., Kelbourn—The city, A. Lettergerodt, Clk. will receive bids until Feb. 24 for equipment including one 150 hp., 50 degree frequency changer set, 25 cycle change to 60 cycle, 2,200-2,400 volts. H. A. Smith, Vroman Blk., Madison, Engr.

Wis., Madison—Dane County, c/o M. Sommers, 512 West Wilson St., plans to build a 4 story, 55 x 100 ft. courthouse (second unit). About $175,000. Additional 350 hp. boilers will be installed in boiler house. Architect not selected.

Wis., Manawa—The Little Wolf River Lumber Co. is having plans prepared for a 1 story, 40 x 54 ft. power plant and lumber mill. About $50,000. T. W. Orbison, 812 College Ave., Appleton, Engr.

Ont., London—The Tecumseh Arena Co., M. B. Percival, Pres., Merchants Bank Bldg., is having plans prepared for a 100 x 200 ft. arena on York St. About $150,000. Private plans. Prices wanted on artificial ice plant and complete equipment.

Ont., Toronto—The University of Toronto, S. R. Falconer, Pres., Queens Park, plans to build a forestry and botany bldg., administration bldg., womens bldg., total cost about $1,200,000, also addition to heating plant to cost about $300,000, at the University on Queens Park.

Sask., Saskatchewan—The University of Saskatchewan, A. R. Greig, Supt., will receive bids until March 1 for dual drive, 100 K.W. dc. generator, 3 wire, 125-250 volt, one drive to be E.H.N.C. turbine; the other to be 2 phase, 60 cycle, 2,200 volt motor.

CONTRACTS AWARDED

Ala., Birmingham—The city has awarded the contract for a 3 story, 20 x 160 ft. high school on 8th Ave. and 24th St., to the Foundation Co. of America, 120 Liberty St., New York City, $486,573. Heating and mechanical equipment separate contract.

Cal., Napa—The Union Ice Co., 354 Pine St., San Francisco, has awarded the contract for an ice plant to A. H. Wilhelm, 180 Jessie St., San Francisco. Total cost including equipment $50,000. Noted Jan. 10.

Ill., Boardstown—The Gorman Ice & Coal Co., has awarded the contract for a 1 story, 30 x 42 ft. ice plant to Wessel & Son, 405 West 7th St. About $25,000. Noted Feb. 14.

Ill., Chicago—The Oetting Ice & Coal Co., 1725 West 15th St., has awarded the contract for a 1 and 2 story, 83 x 156 ft. ice factory at 1717-29 West 15th St. to O. Olson, 3950 North Robey St. About $35,000.

Kan., Independence—The Bd. Educ. has awarded the contract for a 3 story high school, including steam heating system, to Brewster Bros., Independence, $357,047.32. Noted Jan. 10.

N. J., Newark—The Ritz Holding Co., c/o W. Lehman & Son, Archts., 738 Broad St., will build an 8 story apartment on Clinton Ave. About $600,000. Owner will build by day labor.

N. Y., New York—The Bd. Educ., 500 Park Ave., has awarded the contract for the installation of a heating and ventilating system in P. S. 189 on Amsterdam Ave., between 188th and 189th Sts., to J. C. Williams, Inc., 233 Bway., $79,721. Noted Jan. 31.

N. Y., New York—The Friedman & White Realty Co., c/o H. L. Young, Archt., 253 West 42nd St., will build three 6 story apartments on Riverside Drive. About $300,000 each. Owner will build by day labor.

N. Y., New York—The Lapidus Engr. & Constr. Co., c/o G. F. Pelham, Archt., 200 West 72nd St., will build a 9 story apartment on West 69th St. About $650,000. Owner will build by day labor.

N. Y., New York—The Roosevelt Hospital, 59th St. and 9th Ave., has awarded the contract for an 8 story, 50 x 100 ft. addition to hospital to M. Eidlitz & Son, Inc., 41 East 42nd St. About $1,000,000. Noted Jan. 31.

N. Y., New York—A. Sokolski, 217 Bway., will build a 12 story apartment on 64th St. and Madison Ave. Owner will build by day labor.

O., Columbus—The Bd. Educ., E. L. McCune, Clk., has awarded the contract for a 2 story, 200 x 375 ft. high school on East Broad St. to Walbridge-Aldenger, 2350 Penobscot Bldg., $552,860. Contract for heating and ventilating system will be readvertised. Noted Jan. 17.

W. Va., Charleston—The Libby Owens Sheet Glass Co., Toledo, O., has awarded the contract for a 1 story, 64 x 75 ft. addition to power plant and addition to clearing room to Z. J. Bergeron, 1940 Lawrence Ave., Toledo, O. About $50,000.

Ont., Kitchener—The City Utilities Comn. has awarded the contract for the following:—two Beliss & Morcom air compressors to Laurie & Lamb, Bd. of Trade Bldg., Montreal, Que.; motors and electrical equipment to the Canadian Westinghouse Co., Hamilton; one pump to the Buffalo Steam Pump Co., Ltd.; one centrifugal Worthington pump to Stacey Pump & Equipment Co., Excelsior Life Bldg., Toronto; and a steel reservoir to the Horton Steel Wks. Co., Bridgeburg. Total cost $76,000.